1945

NEW ZEALAND

# DEPARTMENT OF SCIENTIFIC AND INDUSTRIAL RESEARCH

(NINETEENTH ANNUAL REPORT OF THE)

*Presented to both Houses of the General Assembly by Leave*

## CONTENTS

## MINISTER'S STATEMENT

THE work outlined in the report indicates steady progress in all directions of research activity, with a gradual preparation for a change-over from the meeting of urgent military requirements to sustained programmes of assistance to longer-term industrial development.

It is now possible to see in more perspective the results of past long-range efforts in certain major directions. The work of the Grasslands Division over the past years in the production of new strains of pasture plants up to the stage where their perpetuation on a high standard could be maintained by a certification system has proved to be sound and capable of exerting ever-increasing economic benefit. Work of a similar nature at the Agronomy Division has served to maintain a high standard of seed for all arable crops despite the vicissitude of the war years. These efforts have also shown that it is possible to produce seed locally of such merit as to obviate the necessity for importation.

The Plant Diseases Division, in addition to exercising its research functions in so far as the main crop diseases are concerned, has developed the counterpart of a certification system whereby fruit-trees of proved quality are available for future requirements of the fruit industries. The activities of the Entomological Division have resulted in an increasing measure of control over pests affecting pastures, rape, and turnip crops, thereby enabling the productive capacity of these crops to be markedly augmented.

The Soil Survey Division has also proved its value, and the demands for soil surveys from all sources are now far greater than can be met. The Division has also been found valuable in connection with a number of works projects both of the Government and of local bodies.

Special attention has been given during the year to the question of implementation of research findings into practice, together with economic and technical reviews of industry in order to ascertain avenues where scientific guidance can be of assistance. For example, using the maps prepared by the Soil Survey Division as a basis land utilization surveys of one county with particular reference to its dairy and sheep industry have been undertaken and valuable deductions have emerged of considerable economic significance with regard to the productive capacity, fertilizer requirements, and management conditions for each soil type.

Steps are well advanced to meet more adequately the needs of manufacturing industries. A Manufacturers' Research Committee has been established and is rapidly ascertaining the nature of the research guidance which our secondary industries require to meet the post-war changed conditions. Research associations have been extended and steps are in hand for direct technical servicing, particularly of smaller manufacturing concerns.

In addition, considerable demands from industry for direct technical co-operation have been met, particularly in regard to testing of products and the provision of special instruments for manufacturing process control. Outstanding service has been given in this regard by the Dominion Physical Laboratory to those factories engaged in essential industries. The Dominion Laboratory has also shown increased activity, over thirty thousand samples having been analysed during the year for Government Departments and industry. Noteworthy achievements have been the design of a seed-drier which has had the effect of considerably increasing the value of certain export seeds, and the constant supervision of the engineering and technical problems associated with the fruit and vegetable dehydration plants now in operation.

All the Department's research institutes have given increased and real service—for example the Wheat Research Institute has evolved a new wheat strain equal equal in yield to Cross 7, flut with a considerably higher baking score and protein content, while, in addition, milling practice has been improved so as to ensure higher food value being secured from the flour produced. Tobacco-research work has resulted in considerable measure of control being secured in the field over mosaic disease and has indicated that it is possible to produce locally high-quality seed, rendering New Zealand independent in this respect.

The Geological Survey has shown increased activity, particularly in regard to the economic minerals—for example, those which have a bearing upon the ceramics, coal, fertilizer, and certain other industries. The staff establishment has been increased in anticipation of post-war requirements preparatory to information likely to be required by the Organization for National Development, while priority has been given to publication of bulletins which have been delayed owing to war conditions.

In order more adequately to collate and disseminate the considerable supply of scientific information now available both from our own efforts and from our overseas liaison officers, an Information Section has been organized and established during the year and is being availed of increasingly. It is hoped that this step will assist in the putting into practice locally of new knowledge. Developments in the technical aspects of industry have been accelerated during recent years all over the world, and a large effort is needed if we are to keep reasonable pace with overseas developments.

D. G. SULLIVAN,
Minister in Charge of Scientific and
Industrial Research Department.

## SECRETARY'S REPORT

THE Hon. D. G. SULLIVAN, Minister in Charge of the Scientific and Industrial Research Department.

I HAVE the honour to submit herewith the annual report of the Department for the year 1944–45.

The Council of Scientific and Industrial Research held five meetings during the year. The personnel of the Council is as follows:—

Sir Theodore Rigg, M.A., M.Sc., F.R.I.C., F.R.S.N.Z., Director, Cawthron Institute, Nelson (Chairman).
J. C. Andrews, Ph.D., M.Sc., Fertilizer-works Manager, Auckland (Vice Chairman).
E. R. Hudson, B.Sc., B.Agr., Dip.C.A.C., Director, Canterbury Agricultural College, Lincoln.
R. O. Page, D.Sc., A.R.I.C., Tannery-works Manager, Christchurch.
J. M. Ranstead, Dip.C.A.C., Bledisloe Medallist, Farmer, Matangi.
W. Riddet, B.Sc. (Agric), N.D.A., N.D.D., Professor of Dairying, Massey Agricultural College, Palmerston North.
D. F. Sandys Wünsch, M.A. (Oxon.), B.Sc. (McGill), M.I.Chem.E., Assoc. Inst.M.M., Factory-manager, Edendale.
E. J. Fawcett, M.A. (Cantab.), Director-General of Agriculture, Department of Agriculture, Wellington.
J. C. Eccles, M.B., B.Sc. (Melb.), M.A., D.Phil. (Oxon.), F.R.A.C.P., F.R.S., Professor of Physiology, University of Otago, Dunedin.
E. Marsden, C.B.E., M.C., D.Sc., F.R.S.N.Z. (Secretary).
F. R. Callaghan, M.A., F.R.E.S. (Deputy Secretary).

The expenditure of the Department during the year was as follows:—

| | £ | £ |
|---|---|---|
| Permanent services. | | |
| Head Office: Comprising general expenses of administration | 20,786 | |
| Dominion Laboratory (with branches) | 39,107 | |
| Dominion Observatory | 1,653 | |
| Geological Survey | 10,967 | |
| Magnetic Observatory | 4,263 | |
| Dominion Physical Laboratory | 80,355 | |
| | | 157,131 |
| Research investigations | | 142,224 |
| Grants and miscellaneous services, including Information Bureau and Scientific Liaison Services | | 25,096 |
| | | 324,451 |
| Recoveries | | 95,906 |
| | | 228,545 |

Grants made to research and allied institutions in Great Britain, £5,784.

During the year consideration has been given to the organization of the Department's work in relation to post-war problems and requirements and a gradual transition of its activities is in progress.

The Department has many and varied functions related to the different fields of scientific work. All these activities are directed to the scientific problems of primary and secondary industries, and Government Departments. It is difficult, therefore, in a short *résumé* to indicate the full impact of the Department's endeavour in all the various fields, but the following short survey covers the main points: chemical work is carried out for Government Departments charged with administering acts and regulations. Engineering and physical research of direct assistance to industry is undertaken, and physical measurements relating to standards. The geological survey of the country's resources is constantly being pressed forward both in general survey and relating to particular minerals and resources. Soil survey, with its particular application to better land utilization, is receiving special attention. Researches in fruit, tobacco, plant diseases, grasslands, agronomy, botany, and entomology are correlated in relation to improving both grasslands and crops. A number of important research associations—dairy, wheat, leather and shoe, wool manufacturing, &c.—are supervised by the Department. Such activities as building research, industrial psychology, and food-preservation investigations are correlated by special departmental committees. Grants are made in aid of research to universities and allied institutions. Industrial contact has been strengthened by the formation of the Manufacturers' Research Committee. Research information, publicity, and liaison overseas have recently been integrated to give better service. Research activities elsewhere in New Zealand in relation to the Department are co-ordinated through the Council of Scientific and Industrial Research.

All these resources have been applied to the war effort, while keeping up local activities of a civil nature as far as possible.

The war experiences have tested out the organization and have, in addition, taught valuable lessons and given emphasis to the following facts:—

(1) The association of research workers in different subjects with urgent practical problems has been a great stimulus to the imagination of workers and has led to novel methods of solution:
(2) There is great value in co-operation and team work between scientists and engineers, and also between scientists working in different fields and in different institutions:
(3) Provided a man has a sound training in fundamentals and the research method, he can, as a rule, do successful work in fields other than that in which he has specialized.

The Department has emerged stronger from its wartime efforts, and co-operation between its various branches on *ad hoc* problems and with other departments is more real and effective.

Although the Department is as yet by no means freed from work for the military services, particularly the Dominion Laboratory, Dominion Physical Laboratory, and special branches, considerable thought has been given to post-war organization, functioning, and requirements. Cabinet has approved of an extension of the number of research associations to serve particular sections of industry and to the principle of their legal incorporation as bodies managing their own affairs in co-operation with the more general scientific services provided by the Department. The Geological Survey has been strengthened in anticipation of further requirements from industry, public works, and the numerous inquiries and investigations asked for by the Organization for National Development and its regional committees. Similarly, the Soil Survey Division has been extended to meet the greatly increased demand from other Departments and from outside sources. An important experiment has been made in North Auckland in evaluating the value of the soil maps in relation to the factors concerned in economic management, production, and potential land use. The results show that the soil survey is conducted on sound lines and has enormous potentialities. The Plant Research Bureau has reviewed its programme in the light of requirements for increased production and post-war requirements, and steps are in hand accordingly, including testing of new grasses at a station in Southland and the development of higher yielding varieties of maize and other warm-climate crops.

Consideration has been given to researches required in two immediately important questions—building and fuel. In regard to the former we have had the benefit of a survey of the position overseas by two of our officers, and also a visit from two senior Australian building-research officers. Further effort is fully justified, particularly in regard to the following matters:—

(*a*) The investigation of problems (affecting buildings already completed and occupied) of heating, insulation, acoustics, and ventilation:
(*b*) The investigation of new materials placed on the market to compete with old-established and commonly accepted materials:
(*c*) The development of substitute materials, methods of treatment of existing materials, and new methods of construction:
(*d*) Co-ordination of effort of Government Departments and private enterprise in the fields of routine testing and research as applied to building and allied industries:
(*e*) The distribution of technical information to interested parties.

With regard to fuel, the programme of work in regard to coal survey has been greatly accelerated. Further aconti is desirable along the following lines, regarding which preliminary work has already been done:—

(1) Design of coal-burning ranges in homes to give greater efficiency of radiant energy and more suitable to fuels now available:
(2) Surveys of industrial plants from the point of view of reduction of consumption of coal required to give the same service:
(3) Briquetting of lignites.
(4) Gasification of lower-grade coals.

The investigation of coal resources is, of course, only one aspect of the general question of fuel and power in New Zealand, whether oil, steam, or other power source, Long-range work is in hand in these various directions.

The Information and Publicity Section has been organized as a separate unit and the machinery built up during the war for the obtaining and dissemination of research information is in process of transfer to civil requirements. It has become increasingly recognized that it is not sufficient for scientists to be aware of the urgency and necessity of extending activities, of undertaking a greatly increased programme of research, but it is also essential that the public realize the importance of the research method and the work contemplated. As a writer in *Nature* has expressed it, "unless there is a general understanding of the achievements and possibilities of scientific research, we cannot expect that there will be forthcoming the public support either in finance or men on which the expansion of our scientific effort to meet the post-war demands and opportunities ultimately depends."

Careful consideration has been given, particularly by the Manufacturers' Research Committee, to the servicing of industry with technical and scientific information called for by the newer processes and products evolved during the war or brought about by the tremendous advances in technology during the past decade. Apart from the organization of research associations and the facilities provided by the Information Bureau there are *real* requirements of the many small ungrouped industrial concerns. Some direct liaison service appears to be called for, particularly during the next two years or so while industrial concerns and organizations may well be in a greater state of flux due to the above causes and rehabilitation generally. The same need has been realized in other countries. Plans to meet this situation have been drawn up, together with appropriate principles governing costing and payments by industry. The Dominion Physical Laboratory, in particular, has been involved in considerable technical servicing of industrial units concerned with munitions contracts not only from the point of view of preparation and calibration of gauges, but in the design and manufacture of special instruments to facilitate process control and new processes. An enormous amount of work has been done and much experience gained. The proper transfer of these activities into the post-war period with a delineation of its functions in relation to private industry is in process of adjustment. This experience, and also that of the Dominion Laboratory, on the chemical problems gives a valuable guide to post-war policy and possibilities.

It is also necessary to evolve a system of dealing with patents arising from discoveries in the various laboratories both in research and development. Consideration of this matter is well advanced.

Discussions are also taking place in regard to the question of training of scientific personnel in research methods by the universities. It is realized that a greater supply of men with higher scientific training will be required, also modifications of the methods of recruitment to the Public Service not only of those who have received their higher training in New Zealand, but those who have proceeded overseas with university scholarships.

E. Marsden, Secretary.

# REPORTS OF RESEARCH COMMITTEES OF THE COUNCIL OF SCIENTIFIC AND INDUSTRIAL RESEARCH

## BUILDING RESEARCH

*Building Research Committee.*—Mr. G. F. Wilson (Chairman), Mr. G. W. Albertson, Dr. J. C. Andrews, Mr. B. C. Ashwin, Mr. L. E. Brooker, Mr. R. A. Campbell, Mr. A. R. Entrican, Mr. F. W. Furkert, Mr. A. R. Galbraith, Professor C. R. Knight, Mr. L. J. McDonald, Dr. E. Marsden, Mr. J. Mawson, Mr. R. A. Patterson, Mr. C. W. O. Turner, Mr. F. J. A. Brogan (Secretary).

Research under the Committee's direction during the year has embraced—

(i) Timber-protection research, including the study and methods of control of timber-infesting insects and fungi (Plant Diseases Division, Entomology Division, and State Advances Corporation).

(ii) Causation and control of mould infestation in houses (Plant Diseases Division, Dominion Physical Laboratory, and State Advances Corporation).

(iii) Investigations of a system of prefabrication in standard concrete and light-weight (pumice) concrete (Auckland University College—Building Research Panel).

(iv) A review of literature on acoustics of buildings was made preparatory to carrying out experimental work, with particular reference, in the first instance, to multi-wall units (Auckland University College—Building Research Panel).

During the year the Committee gave special consideration to a report by the New Zealand Institute of Architects on proposals for earthquake reconstruction in earthquake-danger zones. A sub-committee set up to consider these proposals recommended that a national survey be made by the State of all buildings to determine their structural stability under earthquake stresses; that local investigating committees be set up under the co-ordination of Public Works Department; that the proposals for the classification of buildings drawn up by the New Zealand Institute of Architects be first referred to the Building Code Sectional Committee of the New Zealand Standards Institute for consideration of the question of further guidance for the local committees; and that the results of the survey be referred to the Building Code Sectional Committee for transmission to the Government with suitable recommendations. These recommendations were approved by the Building Research Committee and transmitted to the Hon. the Minister of Scientific and Industrial Research and the Hon. the Minister of Works for consideration by the Government.

The Committee recommended that equipment for testing the fire-resistance rating of building-materials should be provided by the Department of Scientific and Industrial Research so as to enable building-materials to be tested to conform with specifications drawn up by the Fire Resistance Rating Committee of the New Zealand Standards Institute. Consideration is at present being given to the selection of the most suitable type of equipment.

A considerable amount of investigatory and testing work on building-materials of all kinds undertaken at the Dominion Physical Laboratory and the Dominion Laboratory (including the Inter-Departmental Paint Investigation Committee) came under general review by the Committee, so that all work relating to building and building-materials could be co-ordinated as fully as possible.

Mr. J. L. Mandeno, of the Dominion Laboratory staff, returned to New Zealand in March, after spending several months at the Building Research Station, Watford, England, and visiting other institutions engaged in building materials research and testing in Great Britian and the United States of America.

Apart from Mr. Mandeno, the Committee has not yet been successful in obtaining the nucleus of research staff—*i.e.*, a director of research, an architect, and an engineer—which it considers essential to the proper planning, development, and co-ordination of a research programme.

## TIMBER PROTECTION RESEARCH

*Timber Protection Research Committee.*—Mr. L. E. Brooker (Chairman), Mr. E. H. Walden, Dr. D. Miller, Dr. G. H. Cunningham, Mr. R. L. McPhail, Mr. R. L. Andrew, Mr. F. R. Callaghan, Mr. A. F. Clark (Secretary).

### Dominion Laboratory

During the year the Laboratory has carried out chemical analyses and investigations required by the Committee.

### Entomology Division, Plant Research Bureau

*Termites.*—To date over four hundred samples of Australian termites collected in New Zealand have been examined; four species of *Coptotermes* have been identified in this material. Termites have also been collected and identified from imported power-poles and sleepers, and material has been sent from Pacific islands.

Valuable data, having a direct bearing on control, have been secured from a study of the biology of both the New Zealand *Calotermes brouni* and the Australian species of *Coptotermes*. The results of this termite work have been published in part.

*Wood-boring Beetles.*—In addition to the termites, considerable work has been carried out on the biology of *Anobium*, *Ambeodontus*, wood-weevils, *Lyctus*, and pin-hole borers, and tables prepared comparing the various stages of development of these insects and also the type of damage done by each species.

In regard to timber-seasoning experiments, the results indicate that certain timbers may be attacked during the season that they are milled, while others are not susceptible until seasoned for one or more years.

Experiments are also being carried out to ascertain the optimum breeding-conditions for the common species of *Anobium*.

### Plant Diseases Division, Plant Research Bureau

*Biology of Anobium punctatum.*—Erection of a timber insectary during the past year made possible an extension of work on the flight period of this destructive borer insect. Some fifteen thousand beetles were bred, mated, and sexed. A technique for mass breeding has now been developed, providing necessary numbers for therapeutant testing. Long-term experiments have been laid down to ascertain the life-cycle of borer in various timbers, and their susceptibility to its attack. Published results cover an account of the flight period of the species in Auckland, and a paper on its biology is in the press.

In collaboration with the National Film Unit, a cinematograph film was prepared of the Division's work on this insect and shown throughout the picture-theatres of the Dominion.

*Timber-preservative Investigations.*—Work has been mainly on developing methods for testing chemicals which protect timber against borer and fungous attack. Two processes are now being employed in testing effects of preservatives uniformly distributed through test timbers. They make possible the assessment of the toxicities of various chemicals and their approximate toxic level. Six products widely used as timber-preservatives are being tested; results should be available in six months.

An experimental pressure plant is being installed and should be operating in two month's time. By its aid it will be possible to treat samples of timbers used in building-construction by all known methods of pressure treatment and thus ascertain the most suitable process for use with any specific therapeutant and species of timber.

In collaboration with the New Zealand Standards Institute an emergency specification has been drawn to cover dip treatment of certain species of timbers to be used in housing-construction.

### State Advances Corporation

The State Advances Corporation has, as in the past, concentrated on the field investigation of timber-infesting insects and fungi, the application of measures of control of foreign termites, and the field application with preservatives.

*Termite Control.*—The legal authority for carrying out termite-control work is found in the Termites Act, 1940, and its regulations. The field-work this year has confirmed the previous observations, in that the removal of termite nests, although poisoned or in some cases unpoisoned, did not result in the entire removal of the infestation. A special inspection is being made of all areas where termite nests have previously been removed. The number of active termite infestations in Auckland is decreasing, although, unfortunately, new infestations are still being recorded from some areas. The new technique of dusting the insects themselves rather than dusting the runways is still being used and gives good results. The infestation in the Waikohu County (some seventeen miles from Gisborne) appears to be under control, no further insects having been found since the original control measures taken in 1943.

Probably the most serious difficulty facing the termite-control campaign is the lack of a suitably effective method of dealing with infested utility poles. These poles are scattered throughout every infested area and the methods which can be applied in order to combat termites attacking the poles are limited. These methods are sometimes quite effective in that no insects are discovered for a number of seasons, but there is a strong tendency for the poles to become reinfected. Similarly, tramway sleepers are a permanent source of danger, and in Auckland and New Plymouth the infested areas are all situated along or near to tramway systems. Nevertheless, the termite-control campaign is proceeding satisfactorily, but it is obvious that the secret of success in this work lies in its continuity. Some areas will have to be kept under investigation and control measures applied where necessary for several years to come.

*Other Wood-boring Insects.*—The incidence of native termites and the large native longhorn (*Ambeodontus tristis*) is still high, although control measures against the former are proving successful. It has, however, been necessary in cases where native termites occur to reblock the houses in many cases, using concrete instead of wooden blocks. The wooden blocks so often used in the past have been of puriri, and this timber is particularly liable to infestation by native termites.

*Fungi.*—Occurrences on an extensive scale of wood-rotting fungi in houses are rare. Where fungous infestation occurs it is often confined to verandas which are exposed to the weather or base weatherboards in contact with the ground. More extensive infestations may be found on heavy clay sites where inadequate ventilation of the foundation is present. The matter of mould infestation in houses is dealt with under a separate heading.

*Wood-preservation.*—The application of wood-preservatives on a field scale is still proceeding and a very considerable step forward has been made during the past year. It will be recalled from the 1943–44 report that a selection of native and exotic timbers was sent to the Forest Products Laboratory, Princes Risborough, England, where they were experimentally pressure treated with a water-soluble wood-preservative. The results were so encouraging that one firm has lately conducted some test runs on a commercial scale using New-Zealand-grown *Pinus radiata*. This firm has also carried out some tests with native species in shorter lengths using an experimental pressure plant. The preservative used in these tests was Wolman salts. The results of the tests are still being analysed and are not available at the present time.

## MOULD IN HOUSES

*Mould in Houses Research Committee.*—Mr. L. E. Brooker (Chairman), Dr. G. H. Cunningham, Dr. E. R. Cooper, Mr. A. S. Mitchell, Mr. L. R. L. Dunn, Mr. A. F. Clark (Secretary).

Research on this problem was continued through the year by the Plant Diseases Division, the Dominion Physical Laboratory, and the State Advances Corporation.

### Plant Diseases Division

Detailed results of investigations were published during the year (*New Zealand Journal of Science and Technology*) covering work on cause and control of moulds in houses. Investigations showed that discoloration of distempered ceilings and wallpapers of modern houses was caused by several species of fungi growing upon the glue size used for surface treating plasterboard preparatory

to distempering or papering, the casein used as a distemper binding, and flour paste employed to attach wallpapers. Numerous chemicals known to possess fungicidal value were tested with a view to providing an adequate control. Of these the most effectual proved to be sodium pentachlorphenate, which when added to glue size or casein distemper at a concentration of 2 per cent. gave complete control without adversely affecting wallpapers or distemper. Almost as effectual was sodium salicilanylide when used as a 2 per cent. concentration in water and added to the size or distemper.

### State Advances Corporation

The work carried out by the State Advances Corporation with regard to the mould problem consists of the accumulation of field information regarding the distribution of moulds and the application of control measures.

*Distribution.*—The moulds (*Cladosporium* and *Penicillium*) which are at present causing damage to ceilings and linings in houses administered by the Corporation are widely distributed throughout New Zealand. Quantitative data have been obtained which show that the mould damage extends from north of Auckland to south of Invercargill and from east to west of both Islands. There is a tendency for all houses in a group or in a street to be affected, but again one house may be affected while adjacent houses are free, and cases are even known where alternate houses only in a street are affected. Mould infestations have been known to commence in rooms on the south-east side of a house (rooms in this position being generally bedrooms), although it must also be stated that cases where the first appearance of mould has been noticed in rooms in other parts of the house are not infrequent. One of the puzzling features is that rooms which have fireplaces and are therefore better ventilated than others may in some cases be the first to show mould infestation. Commencing in one room, the infestation may spread from room to room until most of the rooms in a house are affected. There is a tendency for infestations to show up first along the stopped joints of the plaster sheets near the cornices, but not necessarily in any particular corner of the house. Ceilings show a marked tendency for infestations to develop over the surface, except those portions immediately under the ceiling joists, and thus a temporary patterning effect is obtained. This, however, is lost as soon as the infestation becomes general.

An investigation of the influence of various types of wall and ceiling finishes showed that distempered ceilings are most frequently infested. It is upon these that *Cladosporium* usually occurs. Papered walls, on the other hand, are nearly always infested by *Penicillium*. The reason why ceilings are so often affected by *Cladosporium* and wall by *Penicillium* is not known. The most severe infestations are found on the ceilings.

*Control Measures.*—The control measures at present taken consist of the addition of 2 per cent. of sodium-pentachlorphenate to distemper and paste or the use of this chemical in a 2 per cent. solution as a wash. Special care has to be exercised, as this chemical is difficult to handle in powder form. In the near future it should be obtainable in briquette form, when handling will be easier, although the difficulty of dissolving the chemical will be made greater. It is too early at present to judge the effectiveness or otherwise of the measures at present being taken. The Corporation, however, has regarded the use of sodium-pentachlorphenate merely as a palliative, and has encouraged, and will continue to encourage, work designed to improve the physical properties of the various linings at present being used.

### Dominion Physical Laboratory

The Laboratory is investigating the physical conditions incident to mould growth in State houses. During the past winter continuous observations have been made in several State houses of temperature, relative humidity, and air movement. In each house two rooms were selected, one showing definite mould growth, and the other free from it. These measurements were made inside the rooms, in the space between the wall linings and outer walls, and outside. The collateral laboratory work necessary for the interpretation of the results is now nearing completion, and it is then anticipated that the physical conditions determining the incidence of mould will become clear and that methods of altering these conditions to eliminate the trouble can be suggested.

## PREFABRICATED CONCRETE AND LIGHTWEIGHT CONCRETE

### Auckland University College—Building Research Panel

*Cast-in-place Concrete Floor on Precast Joists.*—The object of this investigation was to get a comparison with the results of previous experiments on precast joist and slab floor construction (see annual report for 1944) and determine the factor of safety and load factor for the system when subjected to the New Zealand code domestic load of 40 lb. per square foot of floor area.

The range of the investigation was limited, comprising the testing of the materials used, applying a series of repeated loads consisting of one and a half times the design load, and finally applying the maximum load possible with the loading-apparatus used.

Conclusions from the test were as follows:—

(*a*) The beam units will stand all handling and assembly stresses:

(*b*) T-beam action is fully developed:

(*c*) The assembled floor showed a factor of safety of 5·3 for the New Zealand Code domestic loading, the steel being stressed to 81,200 lb. per square inch, which is considerably higher than the usual mild steel of 65,000 lb. to 67,000 lb. per square inch, which would reduce the above factor of safety to 4·3. The test showed a load factor of 9·1, but this again would be reduced to 7·4 if ordinary mild steel were used. (Note.—The steel supplied to-day contains considerably more carbon than the usual mild steel, hence the higher tensile stress.)

*Light-weight Concrete.*—The main objects of this project are to investigate pumice-supplies and uses of pumice concrete, and to obtain data on the properties of pumice concrete.

The scope of the testing-work so far carried out has included tests on crushing strengths, moisture movements, and densities of different concretes made with pumice aggregates. These include tests on specimens made from controlled mixes and also samples of commercial products.

Mechanical analyses were also made of typical samples of pumice from various localities. The following general conclusions from the results so far obtained are taken from an interim report supplied to the Building Research Committee :—

(*a*) Pumice concretes can be made which would be suitable for precast partition slabs to comply with British Standard Specification 492 (1933). Some pumice concretes would make precast blocks for walls which would comply with British Standard specification No. 834 (1939), but further experimental work is needed before it can be definitely stated what are the requirements in the mix used :

(*b*) The *drying shrinkage* and *moisture movement* are usually, but not always, excessive unless a very lean mix is used :

(*c*) There are large differences in the moisture movements of concretes with different pumice aggregates, though they have the same proportion of cement :

(*d*) Pieces of pumice themselves do not have any appreciable moisture movement and the movement must be due to the cement in the concrete :

(*e*) Lean-mix concretes made with suitable pumice aggregates can have a comparatively dry drying shrinkage and moisture movement :

(*f*) The compressive strength of pumice concrete is very low unless a rich mix is used. The strength of very lean mixes is extremely low :

(*g*) Pumice gravels of the " all-in " type, as usually used, are not well graded and contain too much fine material and dust :

(*h*) As with ordinary concrete, the strength is increased by keeping the amount of water down, though the mix must not be too dry. Dry pressure mixes are usually rather too dry, and vibrated fairly dry mixes should give the strongest concrete :

(*i*) The failure in the concrete when it is crushed occurs on the surface of the pumice pebbles with lean mixes, there being a weak bond on that part of the surface of each pebble which was at the bottom during the setting of the cement. This is evidently due to the water in each piece of pumice going to the bottom and weakening the cement bond there. Richer mixes fail through the pumice pebbles :

(*j*) Aggregates of Rotorua pumice give a concrete which is stronger but heavier than that made with alluvial pumice :

(*k*) Replacing the pumice fines with silica sand increases the strength of the concrete and the density can be kept reasonably low. This concrete can be nailed and holds the nails very well :

(*l*) Pumice concretes have a low modulus of elasticity, being about one-quarter of that of ordinary concrete :

(*m*) Reinforced beam tests have shown that a strong structure can be made with pumice concrete, but very little data are available as yet, except that derived from tests in conjunction with precast floor units described below.

*Precast Light-weight Concrete Floor Units.*— The objects of this investigation were—

(*a*) To obtain a comparison with two previous floors which were constructed of ordinary concrete of a density of about 156 lb. per cubic foot :

(*b*) To determine the factor of safety and the load factor for the system when subjected to the New Zealand Code domestic load of 40 lb. per square foot of floor area.

The range of the investigation was small and consisted of testing the materials used and also testing similar units separately. The actual test of the floor consisted in applying one and a half times the design load twice and removing, then applying one and a half times the design load, taking deflection readings each time, and then supplying a further load till failure.

The conclusions from the test were as follows :—

(*a*) The units stood all handling and assembling stresses, but required more careful handling than plain concrete units :

(*b*) " T-beam " action is fully developed :

(*c*) The assembled floor shows a safety factor of 4 and a load factor of 6.

## DAIRY RESEARCH INSTITUTE (N.Z.)

*Dairy Research Management Committee.*—Mr. A. Linton (Chairman) ; Sir T. Rigg ; Messrs. R. A. Candy, G. A. Duncan, H. E. Johnson, A. J. Murdock, W. Linton, W. E. Scott, G. M. Valentine, Dr. E. Marsden (Secretary) ; Professor W. Riddet (Director).

The Committee met on five occasions during the year to review work in progress and to consider new projects. In addition, a combined meeting of the Dairy Research Management Committee, the New Zealand Dairy Board, and the Board of Governors of the Massey Agricultural College was held on the 8th December, 1944, to discuss matters of mutual interest.

During the year Messrs. W. M. Singleton and J. Murray resigned from the Committee. Mr. Singleton was a member of the Committee from its inception in 1927, and Mr. Murray was first appointed in 1930. Mr. G. M. Valentine was appointed by the Dairy Division, Department of Agriculture, to succeed Mr. Singleton ; and Mr. W. Linton was appointed by the New Zealand Dairy Factory Managers' Association as its representative on the Committee, *vice* Mr. Murray.

Research work was limited mainly to the conduct of projects concerned with New Zealand's war effort. Some attention has been given to the part the Dairy Research Institute will play in the post-war development of the dairy industry.

The following subjects have engaged the attention of the staff over the past year :—

*Dry-butterfat Production.*—The large-scale production of dry butterfat was not resumed during the year, but, as requested by the United Kingdom Government, the installation of the standby plant at Frankton was continued by the Internal Marketing Division, and the Institute has co-operated in arranging the layout of the plant and in the design of the various items of equipment. In view of the improvement in the war situation, the installation is not now being continued to completion.

*Body of Butter and Butterfat Composition.*—For two years examinations have been made of butters from two localities where soft body in the butter occurs during the spring. The results for butterfat composition did not give any indication of the cause of the fault in body.

*Vitamin A Content of Butter.*—The samples of butter obtained for the study of butterfat composition in relation to body of butter were also examined for vitamin A content. It was shown that during the 1943–44 season a definite seasonal change in total A content occurred. The minimum total vitamin A content was reached over the months December, January, and February, and the maximum in July and August. The dry season in 1943–44 may have been responsible for the very definite minimum value observed. The spread of values from the average for the butters from the three factories was small, and the butters from all three sources showed a minima and maxima at the same time. The recent Ministry of Food order with reference to the labelling and advertising of food products in the United Kingdom has focused attention on the importance of a knowledge of the vitamin A content of New Zealand butter, and a survey of wider scope has been undertaken.

*Land Cress and Feed Taint in Cream and Butter.*—It has been previously reported that the mustard-oil produced from land cress on maceration is not responsible for the land-cress taint in butter, since water cress yields the same mustard-oil but does not cause land-cress taint when fed to cows. It has previously been reported, also, that land-cress taint does not always occur in cream following ingestion of land cress by the cows. Attempts have been made during the year under review to relate the incidence of land-cress taint in cream from cows fed land cress to the general condition of health of the cows. A connection between incidence of land cress taint and indole, or aceline, content in cream and butter was not found.

*Parchment Wrapping-paper for Butter.*—Examination of parchment paper causing the development of off flavours of butter in direct contact with the paper has shown that the high acidity in the paper was the causative agent.

*Packaging of Processed Cheese in Pliofilm.*—A special filling-machine for the packing of processed cheese in pliofilm has been developed and a batch of five thousand 3 oz. packages was prepared for a special ration.

*Cheese Spread.*—Trials have been made of the preparation of a cheese spread which retains the natural Cheddar cheese flavour.

*Cheese-mite Control.*—Work on this subject has continued in collaboration with the Entomology Division of the Plant Research Bureau. Trials made with dichloroethyl ether show that this substance has great promise as a means of controlling mites in curing-rooms. Its vapour is toxic to mites in very low concentrations, of the order of 0·45 mg. per litre, while its high boiling-point and consequent low rate of evaporation make its effects very persistent. It may be applied to curing-room shelves by spraying, provided the operator wears a respirator, and this will maintain a concentration highly toxic to mites throughout the whole atmosphere of the room for some days, the exact time depending on the amount of ventilation of the room, while in close proximity to the shelves conditions will be unsuitable to mites for probably several months. In a trial in a curing-room unaffected with mites the shelves were sprayed with dichloroethyl ether at the rate of 0·5 lb. per 100 square feet of shelving, corresponding to 1 lb. per 1,000 cubic feet of room space. Mite-infested cheeses were placed on the shelves the following day and the room was closed up again for a further two days. An examination then showed that a complete kill of mites had been secured. Treatment was carried out in August, 1944, and no reinfection had occurred by April, 1945.

*Starters for Cheese-manufacture.*—Isolated starter-rooms and other devices designed to exclude airborne bacteriophage infection of starter cultures have continued to give success in the maintenance of cultures. Detailed improvements are constantly being made, but the basic principles seem to be settled.

Trouble due to failure of acid development in the cheese-vat still occurs due to infection of the factory equipment and infection of the milk delivered from cans which have been used for the transport of whey. The former source of infection is easily checked by chlorination of the vats, pasteurizer, and piping, and factory-managers are tending to adopt such treatment as a routine procedure in the factory. Contamination arising from milk-cans is much more difficult to eliminate. Last year we tried and abandoned a pasteurization of the whey before distributing it to the farmers. Chlorination of the whey was also tried. It proved practicable but costly. The addition of about 4 lb. of chloride of lime to 700 gallons of whey was necessary to check the development of phage. Trials showed that this chlorinated whey did not harm pigs fed on whey and meat meal, in fact it remained sweet for several days, whereas untreated whey usually became "yeasty" and showed fermentation. But a cost of 1s. 6d. to 2s. per vat of cheese made it too heavy a price to pay for the elimination of a trouble which may occur only occasionally.

The tendency at present, therefore, is to overcome the trouble caused by phage infection of the milk by using a series of starter cultures in rotation. We have been able to isolate up to the present six single strains of streptococci suitable for use as starters which are entirely independent in their phage reactions. That is to say, a phage which attacks (and grows upon) any one of the strains will not attack any of the others. Thus it is possible to arrange that the starter in use in a factory on any particular day is not affected by the phage likely to be present in the milk. The system of using a series of cultures in rotation is gradually becoming more widely adopted by managers.

Laboratory work on starter streptococci and upon the phages which attack them has provided evidence that *Str. lactis* and *Str. cremoris* are distinct species. The phages which attack *Str. cremoris* tend to show a strain specificity, whereas those which attack *Str. lactis* are polyvalent. The "cremoris" phages do not in general attack "lactis" strains, and *vice versa*, although there are a few phage races in an intermediate group which attack strains of both species.

Work on the composition of the medium used for growing lactis streptococci has resulted in the discovery of a simpler medium which gives more rapid growth with an elimination of abnormal types of colony.

*Bacteriophage and Mastitis.*—An irrigated treatment with phage has been tried on a few cows suffering from staphylococcal mastitis. The cases are far too few to enable firm conclusions to be

drawn, but the indications are that chronic cases do not respond to the treatment. One or two acute cases have shown rapid recovery, but it is impossible without many more trials to say whether the recovery was spontaneous or due to phage action. Phage treatment of streptococcal mastitis has not yet been tried.

*Cheese-manufacture.*—During the past season experiments in the manufacture of two types of cheese with reduced fat content have been made:—

(1) Cheese with a fat content of 30 per cent. in the dry matter. This may possibly be required for supply to liberated areas in Europe. Its manufacture would make possible the export as a valuable human food of much milk protein at present being converted into pig-meat:

(2) Cheese with a fat content of 52 per cent. in the dry matter. Although years ago the manufacture of standardized cheese was tried commercially and abandoned, there is the possibility that at some time in the future it may be made in New Zealand in order to render economic the use of high-testing milk. The present experiments were designed to determine whether there were any technical difficulties in the production of high-quality standardized cheese.

It was found that the removal of fat from cheese-milk leads to the production of a curd which loses its moisture much more readily in the cheesemaking process than a normal curd. Unless variations from the normal procedure are adopted, therefore, the result is a dry and harsh cheese. The variations necessary are all in the direction of reducing cooking temperature and the period of cooking. This helps to retain the requisite amount of moisture in the cheese so that it will mature normally and develop the usual smooth plastic "body."

It was found that there was no difficulty, given these variations, in making a high-quality Cheddar cheese containing 52 per cent. of fat in the dry matter. When once the correct procedure had been determined it was possible to make a standardized cheese indistinguishable from a normal full-cream cheese.

There was greater difficulty in the manufacture of 30 per cent. fat cheese. Even with extreme variations on manufacturing procedure the cheese was always rather harsh when examined soon after manufacture and it suffered from marked mechanical openness. However, after a maturing period of three to four months the body mellowed to a remarkable degree and it ultimately proved quite edible cheese, although always easily distinguishable from the full-cream product.

*Effect of Feeding of Cows on Characteristics of Cheese-milk.*—In nutrition experiments two groups of cows paired as equally as possible from a production point of view had been fed on pasture, silage, hay, and roots, and one group had in addition received a ration of concentrates. On three different occasions the milks from the two groups were made separately into cheese and their differences in behaviour were observed.

It was found that after a prolonged dry-weather period milk from cows on normal pasture gave the usual soft curd which was difficult to "cook." Milk from the other group receiving an extra ration of concentrates gave much better, although not quite normal, curd. At periods when pasture was in plentiful supply there was no difference between the curds produced from the two milk-supplies: they both "cooked" normally. It was observed, also, that differences between the two curds in a drought period were much more marked than the slight differences in chemical composition between the milk would have led one to expect. Curd characteristics in the cheese-vat seem to be a very sensitive indicator of milk variations due to feed variation and/or environment of the cow.

*Cleaning of Milking-machines.*—The shortage of electric power for use in electric water-heaters on dairy-farms has directed attention towards methods for cleaning milking-machines using the minimum of hot water. During the past season trials have been made of a method used for the last ten years in America and Canada which consists in immersing teat-cups and milk-tubes in a 0·5 per cent. solution of caustic soda between milkings. The soaking treatment in cold caustic soda takes the place of the rinsing treatment with hot caustic solution and boiling water, the present standard practice in New Zealand. So far as the teat-cups and rubber milk-tubes are concerned, the cold-soak treatment gives good results, but in New Zealand there is also an overhead metal milk-pipe and releaser to be cleaned; American machines are almost all of the bucket type. In our trials with two milking-machines a treatment of the overhead pipe with warm caustic-soda solution and rinse of hypochlorite solution was tried. So far as bacteriological quality of the milk was concerned the results were promising, but there was an undesirable formation of scale in the metal pipe due to the hypochlorite solution which would ultimately cause trouble. Further trials with different overhead milk-pipes are projected.

*Dairy Cow Nutrition.*—The 1944–45 season is the fourth in which the production and composition of milk from cows receiving pasture and normal farm supplement—*i.e.*, silage, hay, roots, and green fodder crops—has been contrasted with that from cows which have been fed meal in addition to the above foods. This experiment is designed to determine whether animals fed according to good New Zealand dairy practice produce at a level comparable with that of animals offered an adequate plane of nutrition throughout their entire lactation. It is designed also to determine whether it is possible, by adequate feeding alone, to maintain the normal composition of milk throughout a hot dry summer period.

The results in the seasons (including the current one) when conditions have been very favourable for pasture growth are in marked contrast to those obtained in the 1943–44 season—one in which extremely dry summer and autumn conditions were experienced. Throughout the work, in seasons when a plentiful supply of leafy pasture has been available, no outstanding difference has been observed in the production level and in the composition of the milk from the two groups of animals. During the only abnormally hot dry summer (1943–44) which occurred during the four years of trial, the S.N.F. content of the milk from both groups declined to abnormally low levels. This last point is of special interest, as in previous work at the Institute it has been shown that a low plane of nutrition may depress the S.N.F. percentage of milk. Apparently the availability of sufficient nutrients is not the only factor influencing the decline in the S.N.F. content of milk of cows at pasture in a hot dry summer period. However, it is interesting to note that, although the S.N.F.

content of the milk of both groups was depressed in the dry summer of 1944, the meal-fed group produced at a substantially higher level than that of the group receiving farm grown supplements alone. Furthermore, as mentioned earlier in this report, differences were observed in the curd characteristics during cheesemaking.

*Dairy Cattle Growth.*—From data accumulated from systematic weighing of all available dairy cattle at the Institute over a period of years it has been possible to plot preliminary growth curves for typical Jersey and Friesian cattle grown under conditions of reasonably good management and feeding. Figures have also been obtained on body-weight variation of mature animals throughout lactation and the dry period. These data show the degree to which spring-calving cows, even though well supplied with farm supplementary feeds both prior to and after parturition, lose body weight during the early part of the lactation before regaining and adding to their original condition.

The growth curves of normal dairy cattle frequently show that a break in the trend occurs during the first winter of the young animal's existence. This growth check is due to unfavourable winter feed and weather conditions. In order to determine whether such a check has any effect on the subsequent growth development and capacity for production of dairy stock, the respective performances of two groups of calves are being contrasted. One group, the control, were wintered in 1944 as yearlings under ordinary good conditions of feed and management. The second group were given a higher plane of nutrition during the winter months and established a maximum average advantage of 70 lb. per calf over the control group. When grass growth increased in the spring, both groups were run together and received identical treatment. In April, 1945, the winter high-plane-of-nutrition calves had retained and seemed to be maintaining an advantage of approximately 40 lb. per calf. It is thus interesting to note that, although the control group were not poorly wintered, part at least of the advantage of the group especially well wintered was retained through the summer and autumn of the following year.

*Hormone Studies.*—In 1943 a study was started to see whether, with the present knowledge of the physiology of milk secretion and using the commercially available hormones or their equivalents, it was practicable to increase milk and fat production. Work has been confined to (*a*) experiments on the initiation of lactation with diethylstilbestrol in cases of temporary or permanent sterility; (*b*) the production of iodinated protein having thyroid activity, and the testing of its effects on milk production and composition.

In fifteen dry sterile cows and virgin heifers treated with stilbestrol for periods of two to four months the resulting artificial lactations have given the following yield of butterfat: seven up to 50 lb., two from 50–100 lb., three 100–200 lb., one 214 lb., one 301 lb., and one 438 lb. The substantial productions achieved in some cases are a striking illustration of the possibilities which may lie ahead of this type of work. From the practical aspect the following points are noteworthy. There was great variation in response by different cows to the same treatment. Butterfat yields were below the natural potential production of the animal. A number of the animals were served and became pregnant after the treatment, showing that the injections did not necessarily impair further natural production. At times during the injections many of the animals were in prolonged œstrus. This condition, when accompanied by a relaxation of pelvic ligaments, predisposed the animals to fracture of pelvic bones and was the most objectionable managerial feature of the work. It appears as if some practical application of the technique might be possible, provided that means can be found for obtaining a more dependable response and that the dangers of prolonged œstrus be removed.

The administration of thyroxine and dried thyroid material is known to markedly influence the production and composition of milk. However, both of these materials are too costly for anything but small-scale experimental work. Larger-scale trials have lately become possible through the discovery that proteins may become thyroid-potent when treated with iodine under controlled conditions. After two small lots of a thyroid-potent casein material had been made successfully at the Institute a large batch of approximately 45 lb. was prepared utilizing cheesemaking equipment.

The effect of feeding varying amounts of thyroprotein to eight cows which had been brought into lactation with diethylstilbestrol has been studied. Significant increases in the production of milk and fat were obtained when the preparation was fed at the rate of 20–30 g. daily. The response in milk yield occurred two to three days after feeding commenced and fell off sharply as soon as feeding stopped. A striking rise was observed in fat percentage. It is interesting to note that this did not coincide with the rise in milk yield, but there was a considerable lag of the order of ten days before response in fat percentage. The same lag before fat content declined to normal was observed after stopping the feeding of thyroprotein. The effect on the percentage S.N.F. in milk was not consistent. Considerable interest has been attached to this point, as it had been suggested that the depression of S.N.F. content of milk during hot dry summers might have been linked with some change in thyroid activity. At dosage levels of 15–30 g. daily all cows showed significant increases in heart rate and losses in body weight, emphasizing the extra strain placed on the animal's metabolism and the dangers of overdosage.

*Mastitis Work.*—In collaboration with Dr. C. S. M. Hopkirk, of the Wallaceville Animal Research Station, studies are being made of the worth of a number of irrigants—*e.g.*, acriflavin, tyrothricin—which, it has been claimed, have value in the treatment of mastitis. This work is in its early stages, but it is evident that, although some irrigants have given a measure of success, none used so far have been strikingly effective in eliminating pathogenic organisms from the udder.

*Pasteurization and Bottling of Milk.*—The Institute continued to pasteurize and bottle milk on behalf of the Department of Health for the supply to schools in the Manawatu district.

*Dissemination of Results of Work.*—A large number of dairy-factory managers and first assistants from all parts of the Dominion attended the annual "week" held at the Institute on 9th, 10th, and 11th May, 1944, when research work carried out the previous season was described and discussed. This annual gathering is very much appreciated by managers and first assistants in the butter and cheese industries.

Arrangements have now been made to publish a quarterly bulletin for dairy factories which will be distributed to all concerned. This bulletin will deal with the work of the Institute and with technical developments in the dairy industry and it will enable the industry to keep closely in touch with research work in progress.

## FOOD PRESERVATION AND TRANSPORT ADVISORY COMMITTEE

*Personnel.*—Sir Theodore Rigg (Chairman), Dr. J. C. Andrews, Mr. G. A. Duncan, Mr. E. J. Fawcett, Mr. R. P. Fraser, Dr. E. Marsden, Mr. G. M. Pottinger, Professor W. Riddet, and Mr. F. J. A. Brogan (Secretary).

Owing to the cessation of commercial production of both dehydrated meat and dry butterfat during 1944, research and developmental work during the period under review has been concerned only with dehydrated vegetables and apples, and with the formulation of special rations for use by the Armed Services.

*Dehydrated Vegetables and Apples.*—The Department, through its Chemical Engineering, Plant Chemistry, and Fruit Research Sections, has continued to function very actively as technical adviser to the Internal Marketing Division in matters concerning the technique of vegetable and fruit dehydration. Three factories are now in full-time commercial production of dehydrated vegetables, and a fourth operates throughout the apple season. Two full-time liaison officers have been appointed by the Department, one on the design and engineering side, and the other on the process-control and product-quality side, and have given very valuable service. Other officers of the Department are engaged full time or part time on particular problems of the industry and in obtaining data on the chemical and physical characteristics of raw materials and finished product. These studies commence from the growing and selection of the most suitable varieties of vegetable and follow right through processing to the storage quality of the finished product at ordinary and tropical temperatures, and its culinary and dietetic merit. As a result, substantial improvement has been effected in the efficiency of plant operation, and the quality of the product has been still further enhanced. At the same time, close touch is being maintained with dehydration progress overseas, and in this connection mention must be made of the great assistance given by the Department's Scientific Liaison Officers in Melbourne, Washington, and London. (For further details, see Plant Chemistry Laboratory report and Dominion Laboratory report.)

*Special Rationing for Military Purposes.*—The Fruit Research Officer and the Dominion Laboratory have collaborated extensively with the Food and Dietary Section of the R.N.Z.A.F. to produce a rescue kit and several types of specialized rations for use by the R.N.Z.A.F. and the R.N.Z.N. Special features of these units have been their compactness, waterproofness, high sustaining power, dietetic balance, and stability under a wide range of climatic conditions.

## FRUIT COLD STORAGE RESEARCH

Investigations into refrigerated gas storage and factors affecting superficial scald and core-flush have been taken to a further stage by the Dominion Laboratory, and observations on fertilizer, rootstock, and scion effects on storage quality have been continued by the Appleby Orchard and the Fruit Section, Wellington.

### Refrigerated Gas Storage of Apples

*Sturmer.*—Investigations on the Sturmer variety were continued in the smaller experimental store. Previous years' work on this variety indicated that the optimum storage conditions probably lay within fairly narrow limits as regards both composition of the atmosphere and storage temperature.

The three temperature ranges chosen for this year's work were 37–38° F., 38–39° F., and 39–40° F., and the following gas mixtures were used:—

| Carbon Dioxide. | Oxygen. | Nitrogen. | Carbon Dioxide. | Oxygen. | Nitrogen. |
|---|---|---|---|---|---|
| Per Cent. | Per Cent. | Per Cent. | Per Cent. | Per Cent. | Per Cent. |
| 5·0 | 5·0 | 90·0 | 7·5 | 7·5 | 85·0 |
| 5·0 | 7·5 | 87·5 | 7·5 | 10·0 | 82·5 |
| 7·5 | 5·0 | 87·5 | 7·5 | 13·5 | 79·0 |

There were also two air-stored control samples at each temperature, one at 90 per cent. humidity exactly comparable with those stored in modified atmospheres, and the other in the open store room under constant temperature conditions but lower and fluctuating humidity.

The results obtained indicated that immediately after nine months in store the Sturmer variety was not adversely affected by any of these gas mixtures, and that fruit from each of them was in much better condition than fruit from the control samples. When the fruit was examined after it had been out of store for fourteen days the controls were in very bad condition due to breakdown, scald, wilt, and fungous infection, whereas the samples stored in gas mixtures were still almost free from all diseases. A small amount of fungus had appeared on most samples, and breakdown was also present, but mostly in the samples stored at the lowest temperature range, 37–38° F. None of the other diseases was of any significance. The experiment indicates that even after an extended period of storage the Sturmer variety is tolerant of all the conditions used this year. It would be unsafe, however, to recommend any of these storage atmospheres on the results of only one season, so the experiment is being repeated during 1945.

*Jonathan.*—Five hundred cases of Jonathan apples were again successfully stored in an atmosphere of 7 per cent. carbon dioxide, 14 per cent. oxygen, and 79 per cent. nitrogen. The fruit was held until nearly the end of September, the actual storage period being thirty weeks. The results showed that the fruit kept in the modified atmosphere was far superior to that in ordinary cool storage. Points worthy of note are that once again Jonathan-spot was completely controlled by carbon-dioxide storage, and that fungous infection was prevented to a great extent, even after the fruit had been out of store for fourteen days. Furthermore, the gas-stored fruit was superior in quality and appearance to ordinary cool-stored fruit, and this was confirmed by the records taken for hardness and colour.

The influence of fruit size was examined, and it was quite obvious that with the Jonathan variety counts of 125 and less are unsuitable for gas storage, as they are more liable to breakdown, fungous infection, and storage pit than apples of larger counts. It is even doubtful whether counts

of 138 should be included, as is shown in the following table for gas-stored fruit that has been held subsequently for fourteen days at 68° F. :—

| Count. | Breakdown. | Fungus. | Pit. |
|---|---|---|---|
| | Per Cent. | Per Cent. | Per Cent. |
| 125 | 37 | 12 | 11 |
| 138 | 11 | 10 | 13 |
| 150 | 4 | 7 | 1 |
| 180 | 4 | 8 | 4 |
| 198 | 5 | 12 | 0 |

### Superficial Scald on Granny Smith

*Delayed-storage Test.*—This investigation is a continuation of work that has been proceeding since 1942. This year, fruit of two pickings stored in both plain and oiled wrappers was subjected to delayed storage at weekly intervals up to six weeks. Examinations were made on all the samples in November, irrespective of whether scald had appeared or not, since it was thought that the variety should normally store successfully until then. Other fruit from each sample was placed in a constant-temperature room for fourteen days at 68° F. and 90 per cent. humidity. It was then removed and examined to assess whether the fruit had a satisfactory post-storage life, and also to see whether the most beneficial period of delay was of the same duration as that for fruit examined immediately on removal from store. A further examination was made on each series when all the fruit was showing some scald, but in this case no fruit was placed in the constant-temperature room. The optimum delay, from the standpoint of scald development, is set out in the following table, with the 1943 results for comparison.

| Picking. | Wrapper. | First Examination. | | Second Examination. | 1943 Data. |
|---|---|---|---|---|---|
| | | On Removal. | After Fourteen Days at 68° F. and 90 Per Cent. R.H. | | |
| First | Plain | 4 weeks | 4 weeks | 4 and 6 weeks | 5 weeks. |
| „ | Oiled | No scald | 4 and 6 weeks | 3 weeks | 6 weeks. |
| Second | Plain | 5 weeks | 6 weeks | 2 and 6 weeks | 3 weeks. |
| „ | Oiled | No scald | 3 and 6 weeks | 6 weeks | 5 and 6 weeks. |

The results are not exactly similar to those of 1943, but the two have much more in common than either one has with those obtained in 1942, when scald was least on fruit either stored immediately or subjected to four weeks' delay.

For diseases other than scald the results were similar to those of 1943—viz., core-flush and the form of breakdown that arises from the extension of core-flush into the cortex were decreased by delayed storage, but fungus was increased, especially after periods of four weeks or more.

The limit to the delay allowable, however, is governed by the ground colour of the fruit, and numerical assessments of colour indicated that the maximum period was rather less than that needed for the best control of scald. A revised table showing the maximum period allowable from the standpoint of ground colour at date of removal from storage is as follows :—

| Picking. | Wrapper. | First Examination. | Second Examination. |
|---|---|---|---|
| First | Plain | 4 weeks | 3 weeks. |
| „ | Oiled | 4 weeks | 3 weeks. |
| Second | Plain | 2 weeks | 2 weeks. |
| „ | Oiled | 3 weeks | 2 weeks. |

It should be noted that in all three years oiled wraps prevented scald from appearing in both pickings during the whole of the normal storage life of the fruit. This season no scald appeared on either picking in oiled wraps until mid-January, irrespective of the periods of delay prior to cool storage.

A detailed report of this work is being prepared. A considerably modified experiment on similar lines is being conducted during 1945.

*Wrapping Test.*—In the last annual report it was indicated that fruit that spent most of its storage life in oiled wrappers but was left unwrapped for any three-week period during the first twenty-four weeks of storage remained free from scald until January or February, which is far beyond the normal storage period of the variety. This year an attempt was made to determine how long it was possible to leave the variety without oiled wraps, on either side of the period of maximum susceptibility, before scald appeared. This was done by keeping the fruit without oiled wraps for increasing periods of a week on either side of the ninth to the twelfth week of storage, which had been found to be the most scald-susceptible period. The greatest length of time that the fruit remained unwrapped was from the beginning of the seventh week to the end of the sixteenth week of storage. Two pickings were treated in this way, but no data could be obtained, since scald did not appear at all till February, by which time the fruit was suffering badly from core-flush and breakdown. Although scald could not be induced to appear on the variety during its normal period of storage, such as did appear later indicated that increased periods without protection of oiled wraps caused more and more scald to appear. Leaving the fruit unwrapped either before or after the most susceptible period did not influence the result, nor was there a sharp rise in the amount of scald at any point to indicate a definite period beyond which it would be unwise to leave fruit unwrapped without incurring heavy losses from scald. Since the investigation has not given any results of practical significance, no further work along these lines is envisaged in the immediate future.

### Influence of Rootstock and Intermediate Scion on Core-flush in Granny Smith

Core-flush is generally the most serious disease of Granny Smith apples in cool storage. It occurs much earlier than other diseases and very often is quite noticeable by mid-September. Much of the fruit of this variety comes from trees which have been reworked from some other variety, and it has been suggested that these intermediates might influence the susceptibility of the Granny Smith to core-flush, especially if the intermediate variety is itself susceptible to this disease. It was also thought that different rootstocks might have some influence on the disease.

A postal survey was made of the Nelson and Hawke's Bay districts to ascertain the range of intermediate scion varieties used, and samples were collected from trees that had been worked over from the most important of these intermediates. These were Cox's Orange Pippin, Delicious, Dougherty, Dunn's Favourite, Jonathan, Sturmer, King David, London Pippin, Reinette du Canada, Statesman, and Washington. All these were themselves worked on to Northern Spy rootstock.

In the Nelson district Granny Smith has also been worked direct on to the following rootstocks: Northern Spy, Large's Seedling, Ivory's Double Vigour, and East Malling types XII and XVI.

The results indicate that both intermediate and rootstock can influence the severity of scald in the scion variety, Granny Smith. The most striking results were obtained with the fruit from trees worked on to Reinette du Canada. These samples had the least core-flush of all the double-worked types, and this was true of fruit from both Nelson and Hawke's Bay.

Intermediates which are themselves susceptible to core-flush gave variable results uncorrelated with their inherent susceptibility. In illustration of this, the following table gives typical percentages of core-flush with the susceptible varieties Dunn's and Statesman as intermediates. Data for the best of the intermediates, Reinette du Canada, are given for comparison:—

| Intermediate. | Nelson Fruit Core-flush. | Hawke's Bay Fruit Core-flush. |
|---|---|---|
| | Per Cent. | Per Cent. |
| Dunn's | 69 | 25 |
| Statesman | 50 | 74 |
| | 26 | |
| Reinette du Canada | 20 | 21 |

The two values quoted for Statesman from Nelson are of interest in that the higher percentage was recorded from trees that had been treated with boron to remedy a deficiency of this element in the soil.

As regards the direct effect of rootstock, the worst core-flush (83 per cent.) was found when Granny Smith was worked direct on to Northern Spy stock. This is particularly unfortunate, because the majority of the trees in Hawke's Bay are of this type. The best results were from trees in which the variety was worked direct on to East Malling rootstocks. Type XVI gave slightly better results (22 per cent.) than type XII (25 per cent.).

An interesting feature of the experiment was the way in which the intermediate varieties imparted some of their physical characteristics to the fruits of Granny Smith. This was particularly noticeable in colouring when the intermediate variety was a coloured type such as Dougherty or Delicious. Shape was also liable to be modified, the most noticeable example being the tallness imparted by King David. This work is being continued during 1945.

### Effect of Fertilizers on Cold-storage Quality of Apples

*Cox's Orange Pippin.*—Nitrogen (N), when used alone, continues to increase breakdown and fungous losses, but when it is balanced by the inclusion of phosphate (P) and potash (K) in the manurial programme the storage quality of the fruit is equal to that of untreated control fruit. Superficial scald and storage pit were not influenced to any appreciable extent by manurial treatment.

This season, for the first time, there was a divergence between the effects of ammonium sulphate and dried blood as sources of nitrogen. Ammonium sulphate gave rather less satisfactory storage quality in respect of breakdown and fungous disease.

*Dunn's Favourite.*—The season was characterized by an almost complete absence of severe breakdown in this variety, even after prolonged storage. Though N alone had little effect on breakdown or fungus and none on wilt, it substantially lowered the storage quality, chiefly through a sharp rise in superficial scald. PNK fruit kept almost as well as the untreated, except for a very slightly higher incidence of scald.

An experiment dealing with the rate of application of ammonium sulphate clearly showed the effect of N on scald development. Fruit from trees receiving 0, 2, and 4 lb. showed respectively 1, 10, and 27 per cent. of scald of commercially significant intensity. The trees were carrying good crops and, as has proved usual in such cases, N had no influence on the incidence of fungus or commercially significant breakdown. Similar results were obtained in a liming test, in which an increase in nitrogen status of the trees had been brought about indirectly by lime through better growth of leguminous cover-crops.

*Delicious.*—The PNK fruit was again in every way equal in storage quality to the untreated control fruit, but this year, for the first time, the use of N by itself gave a slightly inferior result, manifest as a small rise in fungus and superficial-scald percentages.

*Jonathan.*—The variety stored exceedingly well this season, and even on long storage there was virtually no Jonathan-spot. In a trial in which all trees received a basic dressing of P and K, a high N application (4 lb. ammonium sulphate per tree) increased susceptibility to fungus and breakdown. With a more moderate application (2 lb.) the storage quality was as good as that of the no-nitrogen control.

In another trial in which a basic treatment of P and N is supplemented by potash in one set of plots, the K-treated fruit continued to show a greater resistance to breakdown and fungus, and also proved more resistant to superficial scald.

*Sturmer.*—N, unbalanced by P and K, again adversely affected storage quality by increasing the incidence of breakdown, superficial scald, and to a limited extent fungus. The inclusion of P to a large extent rectified the position, while the complete treatment, including potash, conferred a storage quality equal on balance to that of the untreated control fruit. Such small differences as did exist showed the complete-treated fruit to have less breakdown and wilt, but more scald, than the control fruit.

### Cold-storage Quality of Coloured Strains of Apples

*Delicious.*—This year sufficient fruit has been obtained from trees grafted with various red strains of Delicious at the Appleby Research Orchard—eighteen types in all—to enable a small sample to be obtained for cold-storage tests. The indication is that most of the types are distinctly inferior to the standard Delicious in storage quality, some being highly susceptible to breakdown, fungous rots, mouldy-core, or superficial scald. One type of Richared Delicious, however, was outstandingly good, and one other apple described as a Red Delicious Sport was equal overall to the standard type.

*Cox's Orange Pippin.*—Three samples of Red Cox and three of Bledisloe Cox all proved inferior to the standard type in storage quality. The Bledisloe Cox appeared very variable, one sample being only slightly inferior to the standard Cox and another being much the worst of any of the types.

*Jonathan.*—Only two variants of the standard type are available at Appleby, one a Red Jonathan (also known as the Kapai Jonathan) and the other a Pink Jonathan. The former was only very slightly inferior to the standard type in keeping-quality, but the Pink Jonathan was distinctly inferior. It has, moreover, a very unattractive appearance.

*Dougherty.*—Two samples of Red Dougherty were compared with a standard type. One appeared to be only slightly inferior to the standard in respect of fungus, ripe-spot, and wilt, but the other developed a substantial amount of ripe-spot as well as a small amount of severe breakdown.

It is to be noted that the data recorded for red strains are based on only single half-case samples and are therefore to be considered as tentative and subject to confirmation in succeeding seasons.

### Effect of Rootstock on Cold-storage Quality

Fruit from the rootstock area at Appleby was again subjected to storage test, although the results with East Malling types XII and XV are still invalidated by the fact that these trees are not yet in full bearing, except with the scion variety, Jonathan. It is possible, however, to get some further preliminary comparisons between M I and Northern Spy, although the results must still be regarded as tentative.

*Cox's Orange Pippin.*—On M I this variety at present has very much better storage quality than on Northern Spy. Differences are very marked in respect of breakdown, fungus, ripe-spot, and pit.

*Jonathan.*—The tentative nature of the current observations is clearly shown by this variety. In the previous annual report it was noted that this variety on M XII was less subject to breakdown than when on the other three stocks under test. This season, however, there have been no significant differences in breakdown susceptibility. On balance, M XII has been rather inferior, chiefly because of a higher incidence of ripe-spot and other fungi.

*Delicious.*—With the Delicious it appears at present that Northern Spy is less satisfactory than M I or M XV from the storage-quality standpoint, particularly as regards liability to fungous attack and proneness to mouldy-core. On M XII the crop is too light to give a valid comparison.

*Granny Smith.*—With this variety only M I and Northern Spy can be considered comparable, from the crop-weight standpoint. The present position is that M I has conferred a considerably greater resistance to superficial scald and to core-flush than has Northern Spy. It may be noted without prejudice that fruit on M XV has kept as well as that on Northern Spy, although the M XV trees carried less than one-third the crop of the Spy trees.

## FRUIT RESEARCH

*Advisory Committee.* Sir Theodore Rigg (Chairman), Dr. G. H. Cunningham, Messrs. W. Benzies, T. C. Brash, F. R. Callaghan, J. Corder, W. K. Dallas, E. J. Fawcett, Hope B. Gibbons, A. Osborne, R. Paynter, A. M. Robertson, H. E. Stephens, and L. W. Tiller (Secretary).

Investigations have been continued at the centres shown below, although the scope of the work continues to be somewhat restricted by shortage of staff on account of the war. The fruit industry is probably unique in the wide range of sciences encompassed in its problems, and a full study of all its difficulties would necessitate a staff many times larger than is at present available. Nevertheless, a wide field of work has been covered and much information of value to the industry has been obtained.

### Research Orchard, Appleby

(*a*) *Long-term Manurial Investigations.*—These are now in their fourteenth year from commencement of treatment, and in general the results of the present season support previous indications that the best results are obtained when phosphate, potash, and nitrogen are all provided for apple trees growing on the Moutere Hills soil. Evidence is accumulating that the use solely of nitrogen can cause decline of trees and render them susceptible to attack by destructive fungi. A brief indication of the economic significance of the effect of various fertilizers, in terms of weight of fruit produced per tree during the season under review, is given below. "N" indicates "treated with ammonium sulphate," "P" signifies "treated with superphosphate," and "K" signifies "treated with sulphate of potash." Throughout the experiments, foliage and shoot development follow closely the yield responses.

Cox's Orange Pippin: N trees produced 97 lb., or 59 per cent., more than untreated controls, and PNK trees produced 119 lb., or 73 per cent., more than the controls. PK trees appeared to carry a little more fruit than the controls, but the difference is not statistically significant.

Dunn's Favourite: N trees produced 49 lb., or 22 per cent., more than the controls, and PNK produced 87 lb., or 38 per cent., more than the controls.

Delicious: PNK trees produced 30 lb., or 25 per cent., more than the controls, but N trees produced 25 lb. less than the controls. Owing, however, to extreme variation in the cropping of individual trees this season the observed differences in average yield between treatments are not statistically significant.

Sturmer: N trees produced 36 lb., or 26 per cent., more, PN trees produced 95 lb., or 76 per cent., more, and PNK trees produced 113 lb., or 83 per cent., more than the untreated controls. Phosphate by itself has not yet given an increase of statistical significance.

(*b*) *Short-term Manurial Investigations.*—Miscellaneous experiments on various aspects of manuring are briefly summarized as follows: Dunn's Favourite trees receiving lime in addition to PNK produced 78 lb., or 23 per cent., more than unlimed trees. On Jonathan trees receiving P and K, 2 lb. ammonium sulphate increased the yield by 86 lb., or 53 per cent., as compared with no nitrogen trees, and 4 lb. increased the yield by 127 lb., or 79 per cent. The 0 lb. and 2 lb. trees gave approximately equal weights of Fancy-grade fruit, but the 4 lb. trees yielded about 22 per cent. less of this grade. Variations in the time or method of surface application of ammonium sulphate have again been without effect on tree or crop. With Dunn's Favourite, 2 lb. and 4 lb. ammonium sulphate per tree increased yields by 74 lb., or 44 per cent., and 165 lb., or 99 per cent., respectively, as compared with the controls receiving no nitrogen. No differences of any kind have been observed between the results obtained with sulphate of ammonia and dried blood as sources of nitrogen. Potash has continued to give improvement in yield and colouring of the Jonathan variety.

(*c*) *Rootstock Trials.*—The trees in these tests at Appleby are now ten years old from date of planting as yearling rods, and substantial crops are now being produced by most trees. It is apparent that the effect of a given rootstock may vary according to the scion variety worked on to it, although the results noted below are not to be regarded as indicative of the relative positions that may be ultimately attained.

With Cox's Orange Pippin and Granny Smith the yields on Malling I and Northern Spy stocks are at present two to three times those on M XII and M XV stocks. With Jonathan, M I, M XII, and Northern Spy are very close together in yield, but M XV is distinctly lower. With Delicious, on the other hand, M XII is at present very much below M XV in yield. Northern Spy is not significantly higher in yield than M XV, although both Spy and M I are very significantly higher than M XII.

(*d*) *Varietal Trials.*—The existing collection comprising coloured strains of popular apple varieties has been added to by the taking-over of budwood material of a considerable number of crosses made by a North Island orchardist. These are to be fruited to determine whether they have any market potentiality.

(*e*) *Spraying Trials.*—These form part of the work controlled by the Plant Diseases Division, and the results are incorporated in the appropriate sections of the fruit report of that Division below.

## Plant Diseases Division, Auckland

### I. *Pomology*

(*a*) *Rootstocks.*—(i) Apple: Growth and yield trials of the varieties Sturmer, Jonathan, Cox's Orange, and Dougherty on a wide range of rootstocks have been continued. Of four woolly-aphis-resistant stocks under test, Merton 779 has produced larger trees than has Northern Spy, with Dougherty as the scion. East Malling XII has again maintained its position as the most vigorous stock, irrespective of scion variety. As fruit-picking is not completed, crop comparisons for the year are not available.

(ii) Citrus: Rootstock influence on growth and flowering of three-year-old Washington Navel trees on sweet orange, sour orange, citronelle, and *Poncirus trifoliata*, and on various combinations of these stocks, is now very marked. Sour orange has in every instance induced stunted growth accompanied by severe chlorosis and profuse flowering, and is obviously incompatible with this scion variety. *P. trifoliata* has hastened flower-formation, while citronelle and sweet-orange stocks have produced the largest trees.

(*b*) *Varieties:* (i) Apple: Of new varieties undergoing trial, Laxton's Exquisite, Laxton's Fortune, and Ellison's Orange are promising early dessert varieties to precede Cox's Orange. Monarch is the most noteworthy of the culinary varieties, being a prolific bearer maturing in January.

(ii) Peach: Twelve new varieties have, during their five years of growth, shown almost complete immunity to leaf-curl. Similar features of tree habit, foliage, and fruit are common to all, separating them as a group from the other ninety varieties being grown at the Division's headquarters at Owairaka. During the year descriptions were completed of the fruits from seventy-five varieties, the purpose being to ascertain the standard type for each.

(iii) Citrus: The most promising of the many new varieties under trial are Kara mandarin, several tangelos, and the grapefruit, Wheeny. The latter is of exceptional quality, maturing later than the New Zealand grapefruit.

(*c*) *Miscellaneous.*—New Zealand Fruitgrowers' Federation Nursery: Work of provincial bud-selection committees has been supervised, additional to activities at the nursery. A further supply of some hundreds of apple stocks was forwarded to the nursery during the year.

### II. *Plant Diseases Investigations*

(*a*) *Therapeutant Testing.*—(i) D.D.T.: Small-scale trials have indicated the value of this and insecticides of similar composition. Control of grass-grub beetles on fruit-tree foliage was secured with a 0·05 per cent. concentration without leaf injury, whereas 1·6 per cent. lead arsenate was largely ineffectual.

Comparable control of carrot aphides was secured with 0·1 per cent. D.D.T. and nicotine sulphate 1–500.

Used as dusts (1 per cent. and 2 per cent.) and sprays (0·05 per cent. and 0·1 per cent.) the product gave excellent control of both white butterfly and diamond-back moth on cabbages.

On apple-trees good control of codling-moth was secured with 0·05 and 0·1 per cent. sprays, results being superior to those secured with standard lead-arsenate sprays of 0·15 per cent.

D.D.T. proved ineffectual against red-mite when applied to apple-trees, the mite population increasing considerably over those on check trees, the increase being apparently caused by killing of predaceous insects which assist in holding red-mite in check.

(ii) Fermate: Encouraging results in control of black-spot of apples was secured with Fermate, a new fungicide with the composition ferric dimethyl-dithio-carbamate which may be used as a substitute for sulphur and polysulphide sprays.

(iii) Copper Oxychloride Products: Cuprox and Oxi-cop have been established in field trials as substitute sprays for Bordeaux mixture in control of late-blight of tomatoes. Trials have been extended to control of diseases on potatoes, celery, and lettuce.

(iv) Derris: Field trials with sprays of ground derris-root, prepared as a suspension in water, on cabbages gave a high degree of control of white butterfly and diamond-back moth at a cost much below commercial applications of nicotine sulphate.

(*b*) *Certification of Therapeutants.*—Quality of certified products has been maintained, minor alterations in standards having been adopted to meet war conditions. Difficulty has been caused by importation of certain lines of non-branded lead arsenates much below the quality of certification standards. In the absence of labels it has been impossible to indicate these particular lines or to advise growers against their use.

(*c*) *Disease Control.*—(i) Bacterial-spot of Plums: Spray trials were carried out in a commercial orchard at Henderson to ascertain optimum concentrations of Bordeaux mixture and number of applications necessary to provide commercial control of this disease. As fruit-setting was negligible, results were inconclusive. Foliage damage followed early applications of 1-3-50 and 2-3-50 Bordeaux to the Japanese varieties, Doris, and George Wilson. Further work on forty-five varieties of plums was undertaken to ascertain the effects on foliage of 2-3-50 Bordeaux and 2·6 per cent. Cuprox. English plums showed little or no damage, whereas Japanese varieties varied considerably in their reactions, some being seriously discoloured and perforated. Cuprox caused greater damage than Bordeaux mixture. The disease was found to be widely distributed in plum orchards in all fruit-growing districts of the Dominion.

(ii) Brown-rot: Spray trials were conducted on peach-trees to test control effects on this disease of high concentrations of lime sulphur applied at blossoming period. Work showed that trees will tolerate high dosage rates, and blossom infection is materially reduced.

Further work was conducted on dip treatment of apricots to control brown-rot developing in transit. Although sodium salicylanilide and Fermate reduced the percentage of wastage, further work is required before commercial control of wastage is secured.

(iii) Ripe-spot: Recommended spray programmes for control of this disease on Sturmer apples have been adopted by orchardists, with the result that losses both in orchard and cool store have been materially reduced.

Reduction of spray russet was secured on Delicious apples by use of summer Bordeaux sprays in place of lime sulphur. Control of red-mite was facilitated by the change, since earlier summer oil sprays could be applied without injury to fruit or foliage.

(iv) Manganese Deficiency in Peaches: In the Roxburgh district trees exhibiting mottle-leaf accompanied by defoliation and loss of vigour were sprayed with manganese sulphate and hydrated lime in 1943-44 season and again during 1944-45. Treated trees are now showing healthy foliage and normal vigour, improvement being most marked on certain trees which were unthrifty and had made little growth in recent years.

(v) Citrus Mottling: Lemon-trees in Kerikeri showing symptoms of a deficiency disease were treated with salts of magnesium, manganese, zinc, and molybdenum at various dosage rates. No differences in tree response have yet been reported.

(vi) Soft-wax Scale: Trials in control of this scale have been continued in the orchards at Kerikeri, confirming previous findings that control is most effectual when spray applications are made during the month of February. Adequate control was secured with one application of 3 per cent. certified summer oil.

(vii) Codling-moth: Investigations have been commenced in the Hawke's Bay Research Orchard to ascertain the seasonal cycle of this pest and thus facilitate improvements in its control.

(viii) Raspberry Diseases: In 1943-44 a 25 per cent. increase in production was secured following four applications of Bordeaux mixture plus lead arsenate in a Motueka district commercial area. Results of the 1944-45 season's trials are not completed, but indications are that yield increases have been maintained. Control of bud-moth, cane-spot, and septoria-spot has been the main factor in increasing yield.

Raspberry-rust (*Phragmidium rubi-idaei*) was found in a Palmerston North nursery in 1944 and has since been located in several commercial areas in Wellington Province. In some cases severe defoliation followed leaf infection.

(ix) Passion-fruit Diseases: A further programme was carried out in the passion-fruit block at Owairaka for control of grease-spot and brown-spot. This season's work was designed to ascertain the minimum number of sprays required for commercial control of both diseases. Results showed that one Bordeaux 3-4-50 application in November, following pruning, and a further three sprays at monthly intervals commencing in April, gave adequate control of both.

### Miscellaneous

*Fruit Dehydration.*—Various branches of the Department have co-operated in carrying out investigational work and in advising the Internal Marketing Division on the dehydration of apples. The investigations have ensured high-quality production from the commencement of the undertaking and have enabled a marked speeding-up of the process to be effected, with consequent increase of output and reduction of operating cost. A constant liaison with the factories is maintained in both the engineering and chemical-control fields.

Preliminary trials have been made on the dehydration of pears, peaches, and nectarines, and extremely attractive products have resulted.

## INDUSTRIAL PSYCHOLOGY DIVISION

*Advisory Committee.*—Mr. H. E. Moston (Chairman), Mr. J. Ferguson, Mr. D. F. Lagan, Mr. E. Langford, Mr. D. I. Macdonald, Dr. Maclean, Dr. E. Marsden, Mr. N. S. Woods, Mr. D. Sandys Wünsch, Mr. L. S. Hearnshaw (Director).

### Progress of the Division

The year 1944 has seen the steady progress of the work of the Division. The Division is now accepted as a body capable of providing a solid and useful service to industry.

Thanks are due to the Councils of Victoria and Canterbury University Colleges for the facilities that they have made available for the work of the Division.

## Research

(1) *Reduction of Fatigue and Monotony.*—The commencement of this research, which was carried out in a small factory engaged on light engineering, was noted in our first annual report. During the present year the task of sifting the data collected during the thirty-two-week investigation has been carried out. The beneficial effects both of music to reduce boredom resulting from repetitive tasks, and of good seating to reduce the fatigue of sedentary work, seem at least strongly suggested by an examination of the output curves. Output was recorded at half-hourly intervals throughout the experiment by means of counters fixed on the machines. A full report will be issued in due course.

(2) *Personnel Records.*—The aim of this investigation was to ascertain what records relating to staff were being kept by some of the leading manufacturing firms in the Dominion, and to make recommendations as to the way in which personnel records should be kept. Visits were paid to some two dozen firms, and information was also obtained from Great Britain and Australia. The results of this investigation have been incorporated into a report which outlines a simple system of record-keeping to suit the medium-sized manufacturing establishment. The report advocates the keeping of the following records: (*a*) an application form; (*b*) an individual record card (including progress record); (*c*) a record of lost time (lateness, sickness, and other absence); (*d*) a record of accidents; (*e*) a record of labour turnover (newcomers and leavers). These records are recommended because experience has shown that efficient personnel-management is difficult without them; and efficient personnel-management is necessary if the sources of friction and discontent, which so frequently disturb industrial relations, are to be removed.

(3) *A Study of Supervision.*—An investigation covering some weeks in a medium-sized factory where morale was poor though working-conditions were good threw some interesting light on problems of management and supervision. The state of affairs in this workroom illustrated the truth that good working-conditions and humane intentions without good supervision do not bring either efficiency or contentment. Production certainly suffered as a result of lax control and weak discipline.

(4) *Student Employment in Essential Industry.*—At the beginning of the 1944 university session a questionnaire was sent to university and training-college students who had worked in essential occupations during the previous summer vacation. The questionnaire was filled in by 1,126 students. The main aim of the investigation was to provide the university authorities with information about the utilization of student labour, and this was presented in a brief privately circulated report. An incidental result was a good deal of information about conditions of work in a variety of occupations.

(5) *The Girl Worker in Industry.*—Investigations in a number of factories employing girl workers mainly on unskilled repetition work enabled us to collect together a good deal of material about the girl worker in industry in relation to this type of work. We believe that some employers are considerably puzzled by the attitudes and behaviour of their girl workers, and, for one reason or another, have a very imperfect insight into their mental outlook. There is room, therefore, for an objective and sympathetic account of the girl worker. We hope to publish our observations in the form of a report.

(6) *The Ventilation and Heating of Factory Buildings.*—A duplicated report on this investigation was issued during the year (price 2s.). A summary of some of the main conclusions was given in Bulletin No. 5 (June, 1944) issued by the Division.

## Education

A course of twenty-four introductory lectures given by the Director at Victoria University College, and covering the whole field of industrial psychology, was well attended by men and women both in Government and private employment. The total enrolment for the course exceeded one hundred and fifty.

A shorter course of twelve lectures by Dr. Winterbourn at Canterbury University College, Christchurch, drew an enrolment of seventy-eight persons and an average attendance of fifty.

A written discussion course of fourteen lectures was also prepared by the Director and Dr. Winterbourn during the year under the auspices of the Tutorial Class Committee of Canterbury University College. The first run-off of some two hundred copies of this course was rapidly exhausted, and a second set of one hundred and fifty copies is now nearly disposed of. It has since been decided to publish the course in book form, and it should be on sale before the middle of this year (to be published by A. W. Reed, Wellington, price 7s. 6d.).

The bulletin, issued quarterly, has had a circulation of over six hundred copies per issue, mainly among New Zealand manufacturers.

Lectures and addresses have been delivered by officers of the Division in Wellington, Christchurch, Dunedin, and Hastings.

## Service

During the year work has been carried out for seventeen industrial concerns. This has included four extended investigations involving from two to four months' work each.

A summary of the investigations carried out during the year follows:—

(1) *Clothing-factory.*—This investigation covered a wide field. Advice was given on heating, ventilation, lighting, and seating. Approximately a quarter of the staff was interviewed in order to find out their reactions to the methods of supervision, working-conditions, and welfare facilities. The organization of executives was overhauled with a view to eliminating overlapping duties. The newly appointed personnel officer was given training in certain aspects of personnel-management. All prospective appointees to senior staff were examined for intelligence, temperament, and special aptitudes. Several problem employees were assisted towards a better adjustment. An investigation into faulty work was made and suggestions made for its reduction. Several operations were examined from a motion study angle with the dual objects of reducing fatigue and increasing output. In four operations production increased 85 per cent., 74 per cent., 55 per cent., and 29 per cent. respectively and the girls found that their work was easier. Largely as a result of an improvement of morale during the investigation, labour turnover decreased from 74·4 per cent. to 21·0 per cent. and absenteeism from 23·6 per cent. to 8·20 per cent.

(2) *Engineering-factory.*—In this firm both labour turnover and absenteeism were on a relatively high level. During the latter part of 1943 the firm lost 33 per cent. of its productive staff, in spite of the fact that it was an essential undertaking, and many of these could not be replaced owing to the difficult man-power situation. The absence rate stood at 7·7 per cent., which must be considered high for a staff composed almost entirely of males. An investigation was made into the underlying causes of the high labour turnover and absenteeism.

(3) *Boot and Shoe Factory.*—A three months' investigation was made into layout, working-conditions, and the handling of personnel. To illustrate the principles of good layout as a means of reducing the fatigue and irritations of work, a completely new layout was devised and installed in one department. Instead of working in hampering clutter and confusion, work in this department now passes freely from one operation to the next. Work is less fatiguing in many cases. The packers especially are obviously pleased with their new workplace, and say that their job is much easier and that there is less confusion. Whereas before many of the operatives were working in draughty positions and a poor light, there are now few complaints of draughts and natural light is much better. It is now possible to work by natural light most of the time instead of artificial. Follow-up inquiries have shown that the layout is proving most satisfactory, and the output of the room has considerably increased.

A survey of ventilation and heating showed that improvements in both were required. Suggestions for improved bench designs and bench layouts were made. Many informal talks were held with supervisors about the handling of their personnel. Particularly in the rooms where females constituted the greater part of the staff there was a lack of discipline and a general weakness in the methods of handling the girls. Assistance was also given in the selection of staff for supervisory positions.

(4) *Household-appliances Factory.* The investigation was principally concerned with an analysis of the bonus system in operation in the firm. The main principle of the system was that the worker got a bonus equal to one-half of the money value of the time she saved on any job, each job having a standard time allocated to it. The bonus system proved popular in principle with the girls, and they were satisfied with the standard times fixed for the job. There was no evidence that the system caused undue speeding-up. For the supervisory and administrative staff, however, it was a constant source of trouble. It was extremely difficult to make all the adjustments which in fairness should have been made to allow for machine hold-ups, production delays, and various other accidental circumstances. From the workers' point of view insufficient attention had been paid to explaining the system in detail to new-comers. The investigation showed that unless great attention is paid to the details of administration, and unless it can be run in an impersonal, objective manner, the advantages of a bonus system are apt to be considerably minimized by attendant disadvantages.

(5) *Foodstuffs-factory.*—Advice given on personnel records, and a sample record card drawn up.

(6) *Textile-factory.*—A survey of factory ventilation. The survey revealed a very unsatisfactory state of affairs. Average air velocities were only 29 ft. per minute, although temperatures in the factory averaged nearly 80° F. At this temperature, velocities in the neighbourhood of 100 ft. a minute would be required to keep the atmosphere reasonably fresh. Relative humidity averaged 79·7 per cent. in the factory, whereas outside the factory the average humidity during the same period was 64 per cent. Such high humidities as that found in this factory are definitely exhausting. Window openings were insufficient to provide satisfactory ventilation, amounting to less than 1 square foot of opening to 100 square feet of floor area.

(7) *Electrical Factory.*—An experiment was carried out on the use of certain standard psychological tests as a measure of the proficiency of apprentices. Twenty-two boys were tested with a series of tests. The results were inconclusive.

(8) *Clothing-factory.*—A series of special selection tests were given to a group of new employees at a small branch clothing-factory. The girls were all inexperienced, and the firm's problem was to allocate them to the most suitable jobs for training. The selection tests greatly assisted the firm in making the best possible placements.

(9) *Dressmaking Workroom.*—A survey covering working-conditions, organization of work, social organization, methods of training, and music at work.

(10) *Dehydration Factory.*—A survey covering working-conditions, working-methods, and personnel-management.

(11-17) *Psychological Examinations.*—Examinations involving the psychological testing and interviewing either of existing members of staff or of applicants were carried out for six firms.

### *Contact with Firms*

During the year personal contact has been made with seventy firms, and fifty-one factories have been inspected. The number of firms on the Division's mailing list now stands at about five hundred, and correspondence and queries have been received from a considerable proportion of them.

### *Factory Seating*

The need for better factory seating in New Zealand was referred to in our first annual report. The adjustable chair mentioned in this report is now in production, after rather long delays caused by material and man-power difficulties, and a number of improvements have been incorporated into the latest models. An illustrated booklet on factory seating ("Good Seating pays a Dividend," price 3s. 6d.) has been issued and may be obtained from the office of the Division.

## Relations with other Bodies

During the year the work of the Division has obtained considerable recognition overseas and we have been in contact with a number of overseas organizations. Reviews of our work have appeared in a number of overseas journals.

Contact within the Dominion has been maintained with the Manufacturers' Federation and associations, the Employers' Federation, the Federation of Labour, the Standards Institute, the Employee Partnership Institute (Hamilton), the New Zealand Vocational Guidance Association, and with several Government Departments.

## LEATHER AND SHOE RESEARCH ASSOCIATION

Director: Mr. P. White. Assistant Director: Mr. F. G. Caughley

### Leather Research Association

*Advisory Committee.*—Messrs. A. E. Lawry (Chairman), C. Arlington, F. Astley, S. L. Wright, R. L. Andrew, and F. Johnston.

In spite of the many advances which have been made in recent years from the results of world-wide research work carried out on leather-manufacture and allied problems, the basis of the assessment of quality in leather is generally that of personal opinion. In forming this considered opinion the person may unconsciously by sight and feel assess at the same time not only many properties, but also their relative importance. The scientist, on the other hand, in his investigations may only be able to measure one property at a time, without any relation to its importance or the effect it may have on any other properties of the finished leather. The problem of the scientist is made still more difficult because some of the so-called properties of leather are selling features associated with appearance and with ease of manipulation in the processes of manufacturing the finished leather article and are not associated with qualities desired by the consumer to give good wear.

The policy of the Association, adopted in previous years, of taking one property of leather, determining the effects of the various tanning processes on it, and at the same time making efforts to determine its importance to the actual wear of the leather has been continued during the year. During any one year only apparently little progress may be made in such investigations. However, over a number of years the Association has accumulated valuable information which enables the tanner not only to associate certain properties of leather to definite processes of manufacture, but also give him the information of how to modify these processes to produce a desired change in any property. In other words, the policy of the Association has been an effort to correlate the tanning of leather with the needs of the leather-goods manufacturer and of the ultimate consumer of leather.

*Abrasion Value of Sole Leather.*—The wearing-away of the sole on a shoe is the cumulative effect of many causes. One of these is the effect of abrasion—that is, the rubbing of the leather against the rough surface of the ground upon which the wearer walks. Many years ago the abrasion-testing machine was made to test this property of leather of resistance to abrasion. Whilst the abrasion values of sole leather may not be an index of the wear value in all conditions of wear, they have to be studied in the light of the previous statement that the scientist may only be able to measure one property at a time. During the year the study of the effects of processes on the abrasion values of sole leather has been continued. The results of this investigation have not only provided a basis for the actual wear test trials, but also emphasized the importance of the quality of the raw hide in determining the resistance of the leather to abrasion.

*Field Trials.*—The thanks of the Association are due to the Army Department for their continued co-operation in carrying out wear tests at Trentham. As stated previously, the basis of the tests carried out during the year was fixed by the results obtained on the abrasion-testing machine. The time necessary to carry out a trial, whilst unfortunately long from a testing point of view, is an indication of the wearing-qualities of New Zealand sole leather.

The field trials have been extended to civilian footwear in order to get a wider range of conditions of wear. In this trial the adjacent test soles are being worn by adults and children in the same family. It is hoped in this way to obtain information which will help in the vexed problem of children's footwear.

*Permeability of Leather to Water Vapour.*—Leather normally allows water vapour to pass through it, and by so doing, in the case of a shoe, helps to maintain an even temperature of the foot. From this aspect the permeability of leather to water vapour is an important function in relation to foot comfort. If perspiration cannot escape through the leather the foot will become hot and uncomfortable.

During the year the effect of processes of leather-manufacture of both sole and upper leather on permeability to water vapour have been investigated. This property is not only important from the foot comfort point of view, but also from that of the life of the shoe. Perspiration rots leather very quickly. The effects of this rotting on the uppers of shoes are seen in the cracks which form in the creases produced by walking.

*Monthly Circular Letters.*—One of the activities of the Association is the publishing of a monthly circular letter. This contains reports on the results of the investigations carried out by the staff and workers overseas and discussions of topics of scientific interest to the tanner. During the year circular letter No. 200 was issued. The value attached to these letters not only in New Zealand but by similar research institutions in other countries shows that these lettters are an important feature of the Association's work.

*Routine Work.*—Routine work is often regarded as unimportant, but the usual checks carried out during the year, on factory processes, raw materials, and finished leathers are necessary if the quality of production is to be maintained.

### Shoe Research Association

*Advisory Committee.*—Messrs. W. Denby, P. E. Edwards, W. S. Livingstone, D. I. McDonald, and R. L. Andrew.

One of the urgent problems facing all industries to-day is that of the best utilization of the man-power available. If the best use is to be obtained, not only must the energy of the worker be carefully directed along the most economic lines but the surroundings in which he works must be such that they will help him to conserve his energy and so give the maximum output for the minimum effort. This is very important in a shoe-factory, where so much of the worker's energy is used in operating machines in which a high degree of accuracy is essential. This accuracy, which is obtained by visual control, places a great strain on the eyes. If this eye strain, with its resulting effects on health and efficiency, is to be reduced to a minimum, good lighting is essential. Good lighting implies that not only the factory itself should be well lit, but that there is sufficient lighting at the point where the actual operation is being performed. Another source of eye strain is the lack of contrast in colour between the material being worked and the machine and the bench. The elimination of eye strain will add to the comfort of the operator, increase the accuracy of the work carried out, reduce the amount of damage done by inaccurate work, and increase the output.

*Lighting of Shoe-factories.*—During past years the importance of good lighting has been stressed by the Association. As a result, many improvements were made which resulted in increased efficiency. During the year a preliminary survey of the lighting in shoe-factories was carried out. Actual measurements of the intensity of light at various points showed the need in some cases for a better lighting system, in others for an alteration of the position of lamps to give more efficient lighting at the point of operation, in others the introduction of properly constructed shades and reflectors was suggested to eliminate glare and increase lighting efficiency. The use of colour schemes to increase lighting effects and to reduce eye strain was discussed. These are already being or will be applied in the near future.

*Shoe Comfort.*—Shoe comfort is generally associated with a good fit, or the use of a good last when the shoe was made. Another factor which affects shoe comfort has already been mentioned in the annual report of the Leather Research Association. If perspiration in the form of water vapour cannot pass through the materials of which the shoe is composed, then the foot may become very uncomfortable. Leather is naturally permeable to water vapour, and the shoe-manufacturer must retain this property in the leather as far as possible. The effect of various processes used in shoe-construction on the permeability of leather has been investigated. In some cases it is necessary to reduce the permeability of leather in order to obtain other features necessary to the structure of the shoe. A balanced compromise is therefore important, and suggestions as to how this should be obtained have been made.

*Factory Problems.*—If the value of the Research Association to the trade may be assessed by the number of problems submitted for investigation, then the past year has been a very successful one. Whilst not a record, the number is well above the average and indicates the interest and confidence of the members in the work of the Association.

*Circular Letters.*—An endeavour is always made to make these letters as practical as possible. Information which may be new is discussed where necessary in its relation to elementary principles which tend to be forgotten when some special new feature is being sought. The principles themselves are not put forward as new, but to serve as a balanced background for further progress.

It is evident from remarks and discussions which occur when the research staff visit the factories that these monthly circulars continue to be read with interest by both management and staff.

### Pelt Research Association

As with other industries, the need for conservation of man-power is being felt in the pelt departments of the freezing-works. Older methods entailing a large amount of man-power are gradually being replaced by labour-saving processes recommended by the Pelt Research Association since its inception. The knowledge obtained by the Association of the fundamental principles involved has enabled these processes to be put into operation without any sacrifice of quality in the pelts.

## MANUFACTURERS' RESEARCH COMMITTEE

*Inauguration.*—Cabinet approved of the setting-up of a Manufacturing Research Committee of the Council of Scientific and Industrial Research to promote research and investigations relating to New Zealand's manufacturing industries, this decision being made following negotiations between the Department and the New Zealand Manufacturers' Federation.

The personnel of the Committee is as follows:—

Representatives nominated by the New Zealand Manufacturers' Federation: A. Dennison, S. T. Hudson, D. Clifton Lewis, F. Morgan, R. J. Rastrick, L. W. Tattersfield.

Representatives nominated by the Council of Scientific and Industrial Research: Drs. E. Marsden (Chairman), J. C. Andrews and R. O. Page, Mr. D. F. Sandys Wünsch.

Secretary-Executive Officer: R. T. Wright, M.Com.

The Committee is representative of a wide range of manufacturing industries and the main districts of New Zealand.

Mr. F. Johnson acts as liaison member on behalf of the Department of Industries and Commerce.

*Functions.*—The principal functions of the Committee are as follows:—

(*a*) To survey the present state of New Zealand manufacturing industry in the light of modern scientific developments, to consider plans for concerted effort to meet the demands of the war and post-war periods, and to make recommendations accordingly:

(*b*) To consider methods for the application of science in development, extension, and modernization of existing industries:

(*c*) To recommend to interested parties and encourage the formation of research associations in appropriate industries, the employment of proper technical assistance in industry, or the investigation of a particular industrial problem by the Department of Scientific and Industrial Research or other scientific institutions:

(*d*) To exercise such other functions as may from time to time be delegated to it.

*Establishment.*—The inaugural meeting of the Committee was held on 29th September, 1944, and two further meetings have been held. Following the recommendation of the Committee, the Secretary-Executive Officer was appointed, commencing his duties on 12th March, 1945.

*Activities.*—The activities of the Committee have mainly been directed to a careful study of the problems involved and to development of its policy. In general the Committee places main emphasis for the immediate future on the organization and provision of scientific and technical information services to industry and scientific testing and servicing. Recommendations have been made in these regards and action has been taken or is in train. The Committee has also given consideration to scientific work bearing on natural resources of interest to manufacturing industry and also to programmes of developmental research as a basis of new industries which may be appropriate to the Dominion. Problems in relation to training of technical executives and personnel have also been considered.

Special attention has been given to the position of New Zealand industries in regard to patents, and appropriate recommendations have been made to the Government.

Publicity as to the facilities available to manufacturers through the Committee from the Department and the need for increased research by industries has been undertaken, and a preliminary and hopeful approach has been made to one additional important industry suggesting the formation of a research association.

The closest degree of co-ordination has been established with the Industrial Psychology Division, and this will be maintained. A scheme has been elaborated for regional scientific servicing in the main centres, with a special experiment in this direction in the Auckland District.

## MINERAL RESOURCES COMMITTEE

*Personnel.*—Mr. C. H. Benney (Chairman), Mr. R. L. Andrew, Mr. W. M. C. Denham, M.P., Mr. W. Donovan, Dr. J. Henderson, Mr. R. F. Landreth, Mr. E. O. Macpherson, Mr. F. J. A. Brogan (Secretary).

The Committee continued to supervise and co-ordinate field surveys and laboratory investigations of mineral resources (except coal, which is dealt with by the Coal Survey Committee), particularly those of wartime importance, carried out by the Geological Survey, Dominion Laboratory, and Mines Department.

*Clarendon Phosphate Deposits.*—Prospecting of the medium and low-grade phosphate in the Clarendon district ceased during the year, and a full report describing the prospecting and giving estimates of quantities and results of sampling has been prepared for publication. A report describing the geology of these deposits and discussing their origin has recently been published as a departmental bulletin.

*Serpentine.*—Geological work on deposits of serpentine rock in North Auckland for serpentine-superphosphate manufacture consisted in checking the geological estimates with the quantities as revealed by quarrying. Serpentine bodies at Te Kuiti and at Blackridge, near Mossburn, Southland, were examined to estimate the amount of suitable rock available, and to advise on their survey and prospecting.

*Mica.*—A deposit of mica was discovered by one of the Department's geologists in South Westland at a considerably lower altitude than that previously located. The deposit, which is accessible at all times of the year, is being worked by Radio Corporation of New Zealand, Ltd., and good-quality mica is being obtained in quantities sufficient for the company's present requirements. Representative samples of trimmed mica from this deposit are to be sent for evaluation to Australia, where mica of certain grades is required for war purposes.

*Clays, Limestone, and Ironsand.*—Other surveys which came under review by the Committee were concerned with clays for pottery, bricks, and tiles; limestone for agricultural and industrial purposes; and ironsands. With regard to ironsands, the Committee recommended that further investigational work on ironsands be undertaken to see whether an economic process of treatment could be devised, particularly from the point of view of simultaneous economic recovery of vanadium and titanium.

## NEW ZEALAND WOOL MANUFACTURERS' RESEARCH ASSOCIATION

Director: Professor F. G. Soper

*Wool Manufacturers' Research Association Committee.*—Mr. W. R. Carey (Chairman), Professor E. R. Hudson, Mr. H. Lee, Mr. E. Moore, Dr. R. O. Page, Mr. T. C. Ross, Mr. G. C. Warren, Mr. W. L. Wood, Dr. E. Marsden (Secretary).

*Non-shrink Treatment of Wool.*—The testing of knitted-wool fabrics for shrinkage after treatment in the New Zealand mills either by the wet chlorination or the dry chlorination process has continued to occupy a large part of the time of the laboratory. Further assistance in the setting-up of the dry chlorination non-shrink process in mills has been given. This process is the one associated with the trade-mark "Woolindras" when the goods are processed in the United Kingdom.

*Service to Members.*—Other service problems have continued to be investigated—*e.g.*, the cause of uneven dyeings, analyses of stains, soaps, and detergents, and of the soap alkali and grease content of scoured wool. Two tours of the members' mills have been made by the chief chemist, and assistance has been given to three mills in designing and equipping mill laboratories.

*Training of Chemists.*—The increasing tendency of the industry to appoint mill chemists has been associated with the institution of an initial course of practical training in the research laboratories of two to three months' duration. This is proving of great benefit and serves as a further link between the mill and the Research Association.

*Essay Prize.*—A prize was instituted in 1944 for the best essay, judged primarily as a contribution to the development of wool textile procedure and knowledge. Good support was received and the prize promises to serve a valuable purpose.

*Institution of Technical Sub-committee.*—A first step in the institution of a sub-committee dealing with various aspects of wool-manufacturing has been effected in the setting-up of the Wet Processes Sub-committee. The personnel are experienced dyers of the woollen-mills. The function of this sub-committee is to discuss the most profitable lines of research work in scouring, dyeing, milling, chlorinating, waterproofing, and other wet processing and to consider reports on these problems prepared by the research staff. So far the work has been concerned with dyeing.

*Dyeing Problems.*—Wool always loses strength in the boiling process associated with dyeing, but some dyeing processes cause much greater loss in strength than others. The conditions causing the losses in strength in woollen-mill dyeings by the metachrome process have been studied by the chief research chemist, Mr. R. V. Peryman, and defects have been elucidated. Arising from this work it is probable that the woollen-mills will be able to make important improvements in this method of dyeing. Extension of these studies to the loss of strength of wool when dyed black is proceeding both by laboratory and mill tests.

## PLANT CHEMISTRY LABORATORY

Director: Dr. R. J. Melville

The principal work of the Laboratory has been in connection with the preservation of food by dehydration. Vegetables and apples have been the subjects of most of the work, though some work has been carried out with stone-fruits and with pears.

*Vegetable Dehydration.*—A study has been made of methods of determination of moisture in the dehydrated product. All methods tried, including vacuum-oven methods, various distillation methods, chemical methods (Karl Fischer method), and vapour pressure methods, have very definite shortcomings. Some compromise is essential and provided the "apparent moisture" by the method used is correlated with the keeping-qualities of the dehydrated product it does not matter much which method is selected if reasonable reproducibility of results can be obtained. Once a standard is set for "apparent moisture" it is essential that the details of the method used must be rigidly adhered to.

As the standard (Monier-Williams) method for the determination of sulphur dioxide in foods is comparatively time-consuming, a search was made for a rapid and accurate method. All published methods tried were open to objection on account of inaccuracy or bad end-points. A method was evolved which gives results in accordance with those of the Monier-Williams method. The estimation can be carried out on dehydrated vegetables and fruits in under fifteen minutes. A paper dealing with this investigation is in course of publication.

The suitability of various vegetable varieties for dehydration and general utility has been the subject of investigation. The study has been largely confined to varieties commercially available. The following varieties are recommended:—

Potato: Aucklander Short Top (New Zealand Sutton Supreme).
Cabbage: Golden Acre.
Carrot: Red Cored Chantenay.
Beetroot: Detroit Dark Red.

The trueness to type of many varieties on the New Zealand market could be very greatly improved, and careful selection work is highly desirable.

As gas-packing of dehydrated vegetables is at present not feasible in New Zealand on account of the difficulty of obtaining gastight tins, the sulphiting of carrot, in addition to cabbage, potato, and kumara, has been recommended. The presence in the dried carrot of 1,000-1,500 p.p.m. of sulphur dioxide considerably extends the storage life of the product.

*Fruit Dehydration.*—Apples: Some difficulty has been experienced in preparing dehydrated apple containing an adequate amount of sulphur dioxide. This is particularly the case with apples having a high acidity. The use of a sulphite dip at about pH 5·8 instead of at the pH of sodium metabisulphite considerably improves the retention of sulphur dioxide. This treatment, however, is liable to cause "bluing" of the fruit with varieties having a high content of tannins (Sturmer and Granny Smith). Bluing is minimized by increasing the acidity, but sulphur dioxide retention suffers. The bluing is associated with the presence of iron in the sulphite bath (either from the water or from the sodium sulphite or acid). The addition of a small amount of phosphate reduces the extent of the bluing considerably, while a combination of alum and phosphate treatments has given satisfactory control at pH 5·8. The peeled and cored apples are given a short dip in 0·5 per cent. alum prior to trimming, and about 0·25 per cent. of primary or secondary sodium phosphate is added to the sulphite bath with approximate pH adjustment.

Pears: Preliminary experiments on the dehydration of pears have been carried out. Steam blanching is recommended, as it improves the appearance of the product and allows much quicker drying. The use of sulphite dips for sulphuring has resulted in "off" flavours and discoloration due to "bluing." Treatment in sulphur-dioxide vapour gives a product of good flavour and appearance.

Stone-fruit: Work has been confined to peaches owing to the shortage of apricots. Steam blanching results in improved appearance and better reconstitution. It also allows quicker drying and greater volume reduction. Sulphite treatment is not advisable owing to the development of "off" flavours. Peaches given sulphur-dioxide treatment after steam blanching dehydrate to a product greatly superior to ordinary dried peaches.

*Vitamin Work.*—An investigation of the content of vitamins of the B complex of vegetable products is being undertaken, and in addition periodical milk samples from the Dairy Research Institute are being assayed.

*Pasture Investigations.*—These have been restricted on account of staff and accommodation difficulties. Analyses in connection with digestibility trials carried out by the Grasslands Division have been made.

## PLANT RESEARCH BUREAU

*Plant Research Bureau Committee.*—Mr. A. H. Cockayne (Chairman), Professor G. S. Peren, Professor E. R. Hudson, Sir Theodore Rigg, Dr. E. Marsden, Mr. E. J. Fawcett, Mr. R. B. Tennent, Mr. C. A. Marchant, Mr. Alan Grant, Mr. F. R. Callaghan (Secretary and Chief Executive Officer).

The Plant Research Bureau now comprises five Divisions and one Section, viz.:—

| | Location. | Director. |
|---|---|---|
| Agronomy Division | Lincoln | *Mr. R. A. Calder (Acting-Director). |
| Botany Division | 8 The Terrace, Wellington | Dr. H. H. Allan. |
| Entomology Division | Cawthron Institute, Nelson | †Dr. D. Miller. |
| Grasslands Division | Tiritea, Palmerston North | Mr. E. Bruce Levy. |
| Plant Diseases Division | Owairaka, Auckland | Dr. G. H. Cunningham. |

* Mr. J. W. Hadfield, Director, was seconded to Linen Flax Section, Industries and Commerce Department, as from 1st June, 1940.
† Associate Director,: Mr. J. Muggeridge.

Participating in the Bureau are (1) the Department of Scientific and Industrial Research and its several research sections; (2) the Department of Agriculture and its various Divisions; (3) Massey Agricultural College; (4) Canterbury Agricultural College; and (5) Cawthron Institute.

## AGRONOMY DIVISION

Acting-Director: Mr. R. A. Calder

The Agronomy Division is concerned with the improvement of arable crops, and this objective is approached by plant-introduction, plant-breeding, and pure-seed production; during recent years the main effort has been directed towards the raising of pure seed, but it is hoped, in the near future, to extend again all other activities.

Approximately 78 acres of crops were grown in the past season.

All crops were grown for the production of pure seed unless otherwise indicated.

### Wheat

The production of nucleus reselected stocks of pure and relatively disease-free seed for distribution under certification is a routine procedure, and during the past year the following varieties were grown from hot-water-treated seed: Cross 7, S.S. Tuscan, Fife Tuscan, College Hunters, Hunters II, Dreadnought, Jumbuck, Marquis.

### Oats

Reselected stocks of Garton's Abundance, Algerians, and Binder, a short, stiff-strawed white oat introduced from Holland, were increased to provide nucleus material for a proposed oat certification scheme.

Eighteen $F_8$ hybrid lines derived from a cross between Resistance and Onward were grown in a replicated drilled trial; the best of these are again to be tested with a view to isolating a high-yielding, good-quality milling oat resistant to lodging.

Fifty-seven $F_6$ hybrid lines from a cross between Algerians and Resistance were studied with a view to isolating an Algerian type resistant to lodging.

Royal Scot and Early Miller, two recent introductions, were grown for observation in comparison with Garton's Abundance.

### Barley

Several high-yielding malting barleys introduced by the Division were again increased by the Canterbury Seed Co. with a view to large-scale malting tests. Golden Archer and Victory are regarded as being promising varieties.

Pioneer, an autumn-sown malting barley introduced from Great Britain, was grown for observation; its performance was satisfactory, but the small unnetted plot was severely attacked by birds in the later stages of maturity; it warrants further trial.

For the coming season arrangements are being made to grow nucleus areas of Spratt Archer, Plumage Archer, and Chevalier to provide material for a proposed barley certification scheme.

A further increase area of Newal, the smooth awned, six-row feed barley obtained from Canada, was propagated.

### Ryecorn

Ryecorn is being grown to some extent in the southern provinces for green-feed purposes, and an attempt is being made either to introduce or to develop a type more suitable than that at present available. Several lines were obtained both from Great Britain and from Australia and these were sown recently as single plants for selection purposes.

### Garden Peas

In accordance with normal procedure, reselected stocks of garden peas were grown on contract for merchants; the following varieties were propagated: Greenfeast, Onward, William Massey, Pioneer, and the new hybrid type, Greencrop.

Hybrid material grown for observation and further selection was as follows: William Massey × (Greenfeast × Greatcrop), 169 lines; William Massey × [(Greenfeast × Greatcrop) × Harrisons Glory] 26 lines; Greenfeast × Greenfeast rogue (mosaic resistant), 42 lines; Greenfeast rogue × (Greenfeast × Greatcrop), 27 lines.

A further series of crosses was made in which Onward was crossed with William Massey, Greenfeast, and Greencrop, the object being the development of a higher-yielding Onward type which might be suitable for canning as green peas.

Several varieties introduced from America and Australia were grown for observation.

### Field Peas

To provide material for certification purposes, nucleus areas of Mammoth Blue, White Prolific, and Mammoth White were grown.

Hybrid material grown for observation and further selection was as follows: Partridge × Lima, 9 lines; Partridge × White Elephant, 18 lines; Partridge × Black Eyed Susan, 60 lines. These crosses are being investigated with a view to the development of an improved Partridge type, but only a few lines from the Partridge/Black Eyed Susan cross show much promise. In a further attempt to effect such an improvement Partridge was crossed with Mammoth Blue, Dutch Blue, and an introduced variety known as Mansholts.

Several White, Blue, and Partridge types received either from America or Australia were grown for observation.

In a trial between Blue Prussian, Mammoth Blue, and Dutch Blue the following relative seed-yield results were obtained: Blue Prussian, 100; Mammoth Blue, 135·3; Dutch Blue, 67·2.

### Rape

Nucleus areas of both B.L.E. I and B.L.E. II [(Giant × B.L.E. I) × B.L.E. I] were grown and the produce passed over to the Department of Agriculture for further increase under certification. A digestibility trial with B.L.E. I, B.L.E. II, Giant, and Giant × Chinese Cabbage was undertaken by the Grasslands Section.

### Kale

To provide material for certification purposes nucleus areas of the "Giant" and "Medium stemmed" types were grown; the produce is to be passed over to the Department of Agriculture for further increase.

Of the hybrid material being investigated, selections from the crosses marrow-stem kale × thousand-headed kale and marrow-stem kale × cabbage were seeded under isolation, while those from the cross marrow-stem kale × kohl rabi were again grown for observation and further selection.

A digestibility trial with "Giant" marrow-stem kale, "Medium-stemmed" marrow-stem kale, thousand-headed kale, and Hungry Gap kale is being undertaken by the Grasslands Section.

### Swedes

A further small plot trial is being carried out at the Division between Garton's Superlative, Garton's White Flesh, Sensation, and the hybrid type Grandmaster × Sensation, while at Lincoln College a large-scale field trial is being undertaken with the hybrid type and Sensation.

A small increase area of the hybrid type located in Central Otago produced 22 lb. of seed; this will be used for further field trials and further multiplication if warranted.

### Sweet Lupins

Nucleus areas of sweet blue and sweet yellow lupins are grown each year and the produce increased under certification by the Department of Agriculture. During the past season a small area of a white-flowering, white-seeded type was also propagated, and the strain is to be multiplied further during the coming year.

Preliminary tests on seed treatment would suggest that polishing considerably improves germination, as indicated by the following results with the sweet blue variety: unpolished seed, 34 per cent. in ten days; polished seed, 90 per cent. in three days.

### Linen Flax

To provide pure seed for distribution to the Linen Flax Section, nucleus areas of Liral Prince Stormont Cirrus, Stormont Gossamer, and Norfolk Earl were grown from hot-water-treated seed.

In September, 1944, Mr. Black attended a conference of Australian linen flax research workers in Melbourne, and also visited the Waite Institute in Adelaide, Canberra, and Sydney. Much valuable information was obtained.

*Introductions.*—Two hundredweight of Norfolk Earl seed was imported from England. Its performance at Lincoln and at Pleasant Point has been disappointing, and unless the quality of the fibre should prove to be outstanding it will be dropped.

Of five Russian varieties received from Canberra, three are immune to the rust present at Timaru. A report from Werribee, Victoria, states that the same three varieties were immune to rust there when infection was so severe that Liral Prince growing alongside set no seed at all. The varieties are (1) Stakhanovetz, which is also said to be resistant to wilt; (2) 806/3; (3) D–83. They appear to be good fibre types, approximately equal in length to Liral Prince and Stormont Cirrus, and superior to Liral Crown and Concurrent in this respect.

Small-scale trials will be carried out next season to test the yield and quality of fibre, and tests of their resistance to various races of rust are to be made in Australia, and possibly here.

If their rust-resistance is confirmed, and if the yield and quality of fibre is satisfactory, these importations are likely to be of great value to the industry.

*Breeding.*—The aim of the breeding programme is to produce a high-grade fibre flax that is resistant to rust and wilt. A second objective is to produce a high-grade seed flax (linseed) resistant to these two diseases. Many crosses have been made between Rio, the rust- and wilt-resistant linseed type parent, and various fibre varieties, Liral Crown, Liral Prince, Stormont Cirrus, Blenda, Hercules, Norfolk Queen, and Concurrent, also with New Zealand Commercial and Giza Purple for seed-production. Most of the first crosses are now in $F_6$. A number of back-crosses to the fibre parents are now in $F_2$ and $F_3$, and many of these have been tested for resistance to *Polyspora* browning by the Plant Diseases Division.

Several hundred selections were sown both at Lincoln and at Pleasant Point, and moderate rust infection at the latter area made it possible for the first time to discard a large number for susceptibility to rust. Unfortunately the infection was not sufficiently severe to enable one to say confidently that the uninfected lines are immune—they may have escaped infection.

During the season 137 successful second back-crosses were made on the 16 most promising looking back-crosses. It is essential that the resistant parents of these be tested for rust-resistance, and this test is being undertaken.

The Australian authorities have presented to us some seed of tested rust-resistant and wilt-resistant crosses between R.A.R. and Liral Crown, Liral Prince, and Concurrent. R.A.R. is Russian × Argentine back-crossed with Russian, and is immune to all races known in Australia and New Zealand. It is also immune or very highly resistant to the flax-wilt races of both countries, under the very severe conditions of their test (soil temperature, 75° F.). This material is too short in the straw for our conditions, and will have to be back-crossed at least once to long-straw-fibre varieties.

*Single Plant Selections.*—Six hundred and seventy single plant selections of the following varieties were grown under netting: Rio, New Zealand Commercial, Norfolk Earl, Norfolk Queen, Liral Crown, Liral Prince, Stormont Cirrus, Stormont Gossamer, Blenda.

*Nucleus Lines.*—Nucleus lines were grown from single plant selections as follows: Blenda, 21; Liral Crown, 40; Liral Prince, 50; Stormont Cirrus, 40; Rio, 40. The first four varieties are now being retted and scutched to determine the fibre percentage and quality, and the best lines will be bulked for increase.

*Manurial Trial.*—A drilled manurial trial was carried out with duplicate plots of lime, super, sulphate of potash, sulphate of ammonia, and borax, both alone and in every possible combination. Small patches of high fertility on the area make it difficult to interpret the results, but during the growing season it was clear that super accelerated growth and maturity, and that sulphate of ammonia

retarded maturity. The highest yields of deseeded straw were from plots receiving potash. Detailed examination of results awaits completion of scutching.

*Pot Trials.*—Pot trials were carried out in the Wheat Research Institute glasshouse to test the effect of varying proportions of L, P, K, N, and B. This material has not yet been examined.

*Weed Control.*—Extensive trials were carried out with Sinox, Sinox plus sulphate of ammonia, and Amnox. The two latter are more rapid in action than Sinox, and are consequently less liable to be washed off by rain falling soon after application. Also, about half the quantity per acre is required to give the same control of weeds as for Sinox, and as the cost of the material is approximately the same, the cost per acre is halved by their use. Unfortunately, the margin between the minimum amount required for a satisfactory kill of weeds and the maximum amount tolerated by flax is very narrow, and the optimum quantity varies considerably with weather conditions, so that at present none of these weed-killers can be recommended for general use. Attempts will be made to devise some method of ascertaining rapidly the correct application under any given conditions.

*Plant Establishment.*—Preliminary trials are under way to find some way of estimating the probable field establishment of any sample of seed. It is known that this may vary widely from the percentage germination in the laboratory. Many factors are involved, but it may be possible to devise some test that will give a better indication of potential field establishment than the present standard laboratory germination test.

### Lucerne

The nucleus area of Strain B was again harvested and the seed distributed for further trials both in New Zealand and in Great Britain. The increase area grown at the college provided approximately 600 lb. of seed, which was distributed by the Department of Agriculture for sowing further seed-multiplication areas.

The mass-selected strain of the spreading species, *Medicago glutinosa*, was harvested and the seed obtained passed over to Lincoln College for trial and further increase if warranted.

### Potatoes

Sixty hydrid lines were propagated in a yield trial at Lincoln and in small increase plots at Kaituna. Most of these are crosses between Katahdin and other imported commercial varieties, local commercial varieties, or *S. andigenum*, a South American species. A large proportion of the lines have become infected to a more or less degree with one or other of the virus diseases, but, nevertheless, many outyield the control, Aucklander Short Top, which is the most popular variety grown commercially.

### Mangels, Carrots, Chicory, and Beans

Small areas of Yellow Globe mangel, of Holmes Improved carrot, of chicory, and of the Hawkesbury Wonder bean were grown for seed-production from reselected stocks.

### Sunflowers

The growing of oil-seed crops in this country would provide additional cash crops for a section of the farming community, and now that an extraction plant has been established in Dunedin it is possible that the acreage sown with linseed will be extended. It is possible, also, that the growing of other oil-seed crops may be warranted, and one which seems worth while investigating is the sunflower. Extensive acreages are grown in Russia and Canada, and an effort is being made to popularize the crop in Great Britain.

Sunflower-seed oil is expressed from the seed of the cultivated plant, *Helianthus annuus*, the cold pressed oil being used for edible purposes and the hot pressed oil or solvent extracted oil being suitable for soap-manufacture; the oil-seed cake remaining after pressing is suitable as a cattle food, especially if the seeds have been decorticated before pressing.

To determine whether the crop might be grown successfully under Canterbury conditions two black-seed varieties introduced from Great Britain and a stripe-seed variety purchased locally were sown in small plots. All varieties developed satisfactorily, and, although flattened during a south-west storm, set seed prolifically; the plots have not yet been threshed, but the yield prospects are good. It is considered that the black-seeded types are preferable to the stripe-seed form for seed-production purposes.

Recently further seed samples were received from overseas, and future work will be concerned with isolating the most suitable variety and in determining whether the crop can be grown economically on a commercial scale.

### Vegetables

It is generally recognized that the quality of the seed of many vegetable varieties offered for sale is far from satisfactory, and it has been considered that an effort should be made to correct this position. As a preliminary step, therefore, a series of varieties of a number of crops is being studied with a view to possible selection and seed-production. This could become a major project.

### Rye-grass and Clover

On behalf of the Grasslands Division, Palmerston North, 5 acres of short-rotation rye-grass (H1), 4 acres of Italian rye-grass, 2½ acres of perennial rye-grass, 1 acre of timothy, and 1 acre each of Montgomery red clover, broad red clover, and white clover were grown for seed-production purposes.

## BOTANY DIVISION

Director: Dr. H. H. Allan

### Identification and Advice

Nearly two thousand specimens were reported on. Scentless wild onion (*Nothoscordum fragrans*) was found to occur in several localities. This species has given much trouble in certain arable areas in Australia. Two Australian species of *Danthonia* were found to be established on hill country near Blenheim, one of which gives promise of being definitely useful.

### Plant Introduction

Further grass and legume seeds have been received for trial on the tussock-grassland experimental areas. A number of the species already under trial have shown promise, and the best of these will be further propagated in the coming season. Seed of local indigenous and naturalized species has been collected for spring trials, including several strains of blue-grass (*Agropyron scabrans*). Several varieties of broom-corn have grown well and will shortly be ready for harvesting. Species of roses selected for high vitamin content in hips have grown well but have not yet flowered.

### Fibre Plants

(*a*) *Phormium.*—Large samples of the varieties 56 and 301 have been sent to a manufacturing firm for trial. The variety 56 proved highly satisfactory for cordage and binder-twine, while 301 was not so outstanding. A report of the Plantation Manager, Moutoa, and the phormium experimentalist indicate that of the other varieties, 313 and 301 are likely to be useful cordage sorts, and SS and 37 for general purposes. Research on " yellow leaf " is being continued and experimental plots laid down.

(*b*) *Linen Flax.*—The experimentalist, in collaboration with the Soil Survey Division, has reported on the last season's work. An analysis of the fibres of crops grown in the Geraldine district was made, with a view to ascertaining any correlations between soil types and fibre yield and quality. Unfortunately, the 1944 season was abnormal and results cannot be safely compared with the previous one. The points investigated were: (1) bundle shape; (2) evenness of fibres within the bundles; (3) fibre shape, lamination, wall thickness; (4) fibre size, number of fibres per unit area of stem; (5) percentage of poor fibres. From the assessment of these points a quality index was obtained. Other factors were studied but not included in the index. A tentative grouping resulted as follows—group 1 (good linen-flax soils): Orari silt loam (quality index, 12); Taiko silt loam, leached phase (quality index, 14). Group 2 (medium linen-flax soils): Waitohi silt loam (quality index, 17). Group 3 (soils unsuitable for linen flax): Orari silt loam, sandy phase (only one crop); Orari silt loam, moderately shallow phase (quality index, 17), Waitohi silt loam, poorly drained phase (quality index, 20). A detailed report is being prepared for publication.

### Seaweed Utilization

(*a*) *Agar.*—The industry is now well established, and the Botany Division is concerned with the raw material, and the maintenance of an adequate supply of suitable seaweeds without permanent depletion of the beds where they grow. Lists received from the Internal Marketing Division were analysed and show that nearly 95 tons of dry seaweed was purchased in 1944, as against 70 tons in 1943. As before, most weed was received in the autumn months. This year more than half the total came from North Auckland, about one-quarter from Bay of Plenty (this had previously been the most important source of supply), and about one-sixth from the East Cape district. In each small locality the yield seems to show a particularly high peak in the second autumn, followed by smaller quantities in the third. This indicates that the beds need time to recover, and that it would be unwise to encourage closer picking by raising the price, lowering the standard of cleaning required, or otherwise. Inspection of typical beds in all the principal areas confirmed this view.

Rate of consumption of weed at the factory is now approaching rate of collection, and the output of agar is showing a corresponding increase. The manufacturing firm is constantly improving its plant and its technique, and greater yields should be won as experience increases, provided the weed received is reasonably clean.

A notably high gel strength is apparently characteristic of *Pterocladia* agar. Its practical significance is that 1 part by weight of New Zealand agar goes as far as 1·6 parts, at least, of Japanese, and in some commercial uses can replace 4 parts of Japanese.

The New Zealand product is of very good colour and is being used for most, if not all, of the purposes for which imported agar was previously needed. A considerable quantity has already been exported.

A paper on New Zealand seaweed for agar-manufacture was published in the *Journal of Science and Technology*, and there is in the press an account of the New Zealand representatives of the genus *Pterocladia*, which includes our important agar seaweeds.

(*b*) *General Survey of Seaweed Resources.*—New stretches of coast were examined in North Auckland (West Coast), Bay of Plenty, East Cape district, Hawke's Bay, Cook Strait, North Otago, South Southland, and Stewart Island. In the North this work was fitted in with agar business, and in the South was incidental to a review of the carrageen situation, with an eye especially to post-war prospects for this crop.

The algal herbarium has been increased by some two thousand sheets, and the Dominion Museum, Auckland Museum, and Canterbury College collections have been extensively consulted. Exchange with overseas workers has brought useful help with specimens and literature.

Consignments of seaweeds from island territories have been identified and tests made for possible economic uses. Many local inquiries have been dealt with.

### Weed Investigations

(*a*) *Nassella Tussock.*—Grassing experiments on unploughable hill country in North Canterbury were laid down, and a further series with additional species is arranged for. Further field-work on distribution was undertaken. A detailed bulletin covering all phases of the problem has been published.

(*b*) *Kangaroo-grass.*—Experiments on the possibility of control by means of spring burns were made in co-operation with the Marlborough Sheepowners' Federation.

(*c*) *Gorse.*—The gorse areas on Banks Peninsula were examined and reported on, and suggestions concerning control made. Work on seed-germination in the field and laboratory was continued, and mapping of the gorse areas about Wellington is proceeding.

(*d*) *Vacated American Military Camps.*—American camps in the Auckland-Pukekohe area, and the Whenuapai Aerodrome also, were examined. While no further imported weeds had established, it

was found that significant quantities of seed had come into the country in gear and tents. Recommendations were made as to treatment. *Bromus rubens*, a Mediterranean grass naturalized in the United States, was found to be establishing on the camp site previously occupied by American servicemen at Paekakariki.

### Alien Flora

Work has proceeded with a view to a second edition of "The Naturalized Flora of New Zealand." Since it was published a number of new species have been found to be established and further details of distribution learned. Several genera have been subjected to critical revision. In conjunction with this work the publication of a manual on the control of the major weeds is projected.

### Medicinal Plants

Work has been mainly confined to completing the sampling of the different species grown for analysis, and to maintaining supplies of seed of species likely to be called for.

### Russian Dandelion

A full report was furnished during the year. It was considered unwise to advocate an attempt to establish kok-saghyz growing on a commercial basis till the findings from the small-scale experiments made by the Division could be tested on a large-scale field trial. Previous small field trials had not shown much promise. Our own trials indicate (1) that the soil must be deep, preferably with a water-table at a depth of about 6 ft.; (2) the climate should be relatively dry, with plenty of sunshine; (3) kok-saghyz should be preceded by a good weed-smothering crop; (4) on soils deficient in nitrogen either organic manure should be provided or a leguminous crop ploughed in well before the seed is sown. There is evidence that October is the best month in general for sowing, and that 14 in. drills at the rate of 2–2½ lb. of seed per acre are most suitable. The seed should not be placed more than ½ in. deep. Plots were sown last spring for observational and seed-supply purposes. These, up to date, are doing well.

### Tussock-grassland Investigations

In addition to the areas mentioned in the previous annual report, a further experimental area ha been established at Lindis Pass. This is in "snow-grass" country and will provide a useful comparison with those in low tussock-grassland. The more detailed work on the Molesworth area has been continued, and a nursery area established at the homestead. Examination of the progress of sowings on all the areas will be made during the coming year and the information gained reported on.

### Erosion Control

An examination of the Mount Bruce area was made for the Wairarapa Catchment Board, and further field-work is in progress in the area controlled by the Board. At Mount Bruce it was found that the area was well protected vegetatively from erosion. Quadrat studies were made on the Wither Hills Conservation Area, and the marked plots will be examined periodically.

### Peat Investigations

A detailed study of a peat area near Wellington is in progress, accompanied by laboratory work. The "pollen analysis" technique has proved a very useful adjunct, and reference material has been built up comprising 2,264 slides. Some 80 peat samples are being examined as to pH, ash, and pollen stratigraphy. In addition, a study of vegetable remains and woods has been commenced. Preliminary work has been done on other peat areas with a view to ascertaining how far botanical studies can assist in the work on copper deficiency and peat reclamation and utilization in general.

## ENTOMOLOGY DIVISION

Director: Dr. D. Miller. Associate Director: Mr. J. Muggeridge

### Mite Investigation

This activity mainly centres around the mites infesting cheese, though some work has been done upon the control of mites attacking other products.

*Cheese-mites.*—The survey of cheese-factories has been extended to the early spring, when mite population, it was considered, should be at their minimum following winter and the annual cleaning of curing-rooms. The position, however, was the reverse, in that in all but one of the factories examined there was extreme mite infestation. This strengthens the former conclusion that the initial mite infestation of cheese occurs in the factory curing-rooms and that such infestations cannot be controlled until the practice of keeping second-grade and reject cheese in the curing-rooms has been discarded and a thorough regular cleaning of the curing-rooms resorted to.

A study of the cheese-mites reveals that two species are almost exclusively responsible for infestation in curing-rooms and that these species attack in a definite succession. A study of the physical ecology of these mites is being carried out, correlated with reactions to fumigants, a most important one of which is dichloroethyl ether.

### Cocksfoot Stem-borer

The life-history studies on this insect have been completed. Experimental areas have been sampled to ascertain the correlation between infestation and seed yield. Different methods of management were studied with a view to controlling the borer; indications are that, of the methods tried, burning stubble in the spring has a most pronounced influence in reducing infestation. The rapidity with which the insect invades a cocksfoot crop from adjoining heavily infested areas is being studied.

### Grass-grub

A long-term research project into the grass-grub problem has been initiated. This involves a survey of the various grass-grub species and their range, the ecology of the destructive species having the possibilities of control by pasture management in view, and the utilization of natural controlling factors—disease, parasitic worms, and parasitic insects.

The systematics and distribution of the grass-grubs and beetles have been seriously studied for the first time and important data secured as to the different species, together with important information on host-plant relationships.

In regard to natural controlling factors, work has commenced on the possibilities of a bacterial disease and of a parasitic nematode worm against the common grass-grub. Insect parasites that are required do not occur in New Zealand, but are well represented in Australia, where a special research is to be undertaken to secure species which will be of use in solving the grass-grub problem.

### Diamond-back Moth

This moth, which has been a pest on cruciferous crops (approximately 600,000 acres of these crops are grown by farmers annually) such as rape, turnips, swedes, and chou moellier, over the last sixty years or more, and over which period thousands of pounds of destruction to these crops has resulted, is now showing signs of being well controlled by parasites. In the last annual report it was mentioned that the degree of control attained in the North Island "reached a high peak of efficiency," while in the South Island the report states "the same degree of success has not been reached as in the North."

A field survey and inspection of crops during the present season has just been completed. The areas covered in the North Island include Wellington, Manawatu, Wanganui, Taranaki, Hawke's Bay, and the Wairarapa, and in the South Island include Nelson, Marlborough, North and South Canterbury, and Northern Otago, and it is very pleasing to report that the position this year in the North Island is even better than it was last year, while the position of the crops in the South Island is such that the control of the moth here and the condition of the crops generally is at least equal to the control being obtained in the North Island. In so far as market or vegetable gardens are concerned, none has been examined, for the reason that practically all these gardens are sprayed heavily; the spray recommended is probably just as toxic to the parasites as it is to the moth caterpillar. It should be pointed out, however, that cabbages in particular appear to suffer more from attacks by the diamond-back moth than most other crops, so what degree of control might be obtained in the absence of sprays would hardly be sufficient perhaps to check injury, so that no economic loss would result. The method of estimating the degree of prevalence of the moth is based on the number of moth pupæ collected for a given period of time—for example, ten minutes—and also on the condition of the crop. When this work first commenced it was a very simple matter to collect hundreds of diamond-back moth pupæ over a very short period of time. Collection on crops during 1939 and 1940, for example, frequently yielded anything from fifty to one hundred diamond-back moth pupæ per ten minutes of collecting; it would take hours of collecting during the present season to get anything like the same number of pupæ, and in no case after inspection of hundreds of crops has any crop shown signs of being seriously damaged by diamond-back moth. How far the present condition is due to season, such as consistent rainfall, high humidity, and phenomenal crop growth, one is unable to say, but it is clear that the parasites are playing a very major role and are responsible for the high degree of control which it has been found exists during the present season.

### White Butterfly

The present season has been one in which white butterfly has been able to cause quite a lot of damage to cruciferous crops. The wet conditions under which the butterfly seems to be able to multiply have been widespread. In order to improve the control of white butterfly by parasite means, some work on collecting and distributing larval parasites has been carried out. The larval parasites have been established in Nelson for some time, and it has not been possible to distribute them farther afield because of lack of staff to undertake all work which occurs at this period of the year. During the present season, however, some larval parasites have been distributed in Ashburton and in Hawke's Bay, as once they are established in these localities they should spread fairly readily over the rest of the cruciferous-growing areas.

### Case-bearing Clover-moth (Coleophora Spissicornis)

This moth appears to be increasing in the Hawke's Bay area and is apparently causing a good deal of loss of white-clover seed. Unfortunately we do not know of any suitable methods of controlling it at the present, and there is little that can be done about it until the matter is fully investigated.

## GRASSLANDS DIVISION

Director: Mr. E. Bruce Levy

The past year has been a remarkable one for growth, but the persistent wet summer has made cultivation and general upkeep difficult. A very full programme has been maintained and the work continues to expand. The entire lack of any suitable building is more and more adding to the difficulties of staff and administration.

### Plant-breeding

A primary function of the Grasslands Division is the breeding of improved strains of pasture species. The majority of our pasture species are characterized by extremely wide variation between strains and between the constituent plants of any one strain. Over the last decade strains of a number of our most important pasture species have been bred at the Grasslands Division and have proved superior in the field to the strains previously available to the farmer. There are still many directions in which further improvement is desirable, and gradual improvement by breeding is being applied to existing bred strains. Further than this, however, entirely new strains are being bred by hybridization between strains or even between species.

Although the shortage of staff is still acute, the breeding programme during the year has been maintained as far as possible. The main species under study are perennial rye-grass, Italian rye-grass, short-rotation or H1 rye-grass, Western Wolths rye-grass, cocksfoot, timothy, white clover, and red clover. Of these species, bred lines of perennial rye-grass, Italian rye-grass, H1 rye-grass, white clover, Montgomery red clover, and broad red clover are now on the market as Government certified strains. Of the remaining species, pedigree strains have not yet been produced for distribution.

*Perennial Rye-grass.*—Seed from the pedigree strain of perennial rye-grass is now widely used in sowing down new permanent pastures. Breeding is being continued to maintain or gradually improve this type.

The supply of seed of perennial rye-grass and hence its greater use in the production of new pastures has been curtailed to some extent by periodic attacks of the blind-seed disease to which this type of rye-grass is susceptible. Hence an attempt is being made to breed a strain of perennial rye-grass resistant to this disease. This will be a very long-term project. It has been found that resistance and susceptibility to the disease are inherited characters, and crosses have been made in an attempt to combine this disease-resistance with the other desirable characters of pedigree perennial rye-grass.

*Italian Rye-grass.*—In recent years an attempt has been made to increase the persistency of Italian rye-grass without reducing the important characters of rapid establishment, early growth, and high first-year production which have already been bred into this species. Persistency trials in which the most recently produced bred line has been compared with other lines have shown in the most recent line 64 per cent. of the plants surviving after the first year compared with no survival in a non-pedigree line. The second-year production of this pedigree line should increase the usefulness of this species.

*Short-rotation or H1 Rye-grass.*—This type of rye-grass, which has been evolved by hybridization between perennial and Italian rye-grass, has now been released and is in very keen demand.

Different types of this rye-grass have been released for trials. From comparisons of these types under pasture conditions at Palmerston North, Marton, and Lincoln valuable information has been gained as a guide to further improvement of H1 rye-grass. Attention is now being directed towards increasing its persistency without reducing appreciably the important characteristic of "out-of-season" production.

*Western Wolths Rye-grass.*—The requirements in a Western Wolths type of rye-grass are that it will produce, when sown in the early autumn, a greater bulk of feed in the autumn, winter, and early spring than Italian rye-grass.

A mass selection of Western Wolths has now been made from plants studied in the field last season and a small seed-supply obtained. This has been sown in pasture trials at Palmerston North and Lincoln in comparison with pedigree Italian rye-grass and with Algerian oats so as to obtain information on the relative value of these three species as a special-purpose temporary pasture.

*Cocksfoot.*—Mass selections have been made of three different types of cocksfoot, and these will be sown this autumn in comparative pasture trials to provide information as a guide to future breeding-work with this species. Concurrently, progeny tests with selected plants of various types are being carried out.

*Timothy.*—A nucleus supply of seed has been obtained of a type of timothy very similar in many characteristics to the Welsh Plant Breeding Station S48. This is a much higher-producing and leafier type than the usual imported or New-Zealand-grown timothy. This nucleus supply of seed will be used for small-scale pasture trials and to provide a nucleus for a larger supply of seed.

*White Clover.*—No further breeding-work with white clover is at present being undertaken, except in so far as is required to maintain the nucleus supply of seed of the pedigree type.

*Montgomery and Broad Red Clovers.*—Pedigree seed is available of both of these types and further breeding is being directed towards improvement of these strains. The possibility of producing a highly productive persistent strain by hybridization of Montgomery and broad red clover is also being investigated.

## Strain Ecology

*Nucleus-seed Production.*—The season has been a most unfavourable one, but even so satisfactory crops of the several grasses have been harvested. The amounts of nucleus seed obtained have been as follows:—

| | Grasslands Division. Bushels. | Agronomy Division. Bushels. |
|---|---|---|
| Nucleus stock perennial rye-grass | 16 | 56½ |
| Nucleus stock Italian rye-grass | 40 | 198 |
| Nucleus stock short-rotation rye-grass | 20 | 163 |

The nucleus clover crops are very late maturing this year and are not yet threshed.

A feature of the grass-seed crops this year has been the high moisture content of the seed when harvested. Some samples were of 32 per cent. moisture content, and these had to be carefully dried and conditioned to approximately 11 per cent. of moisture before they could be safely put into storage.

The scheme for the provision of nucleus-stock seed and the contract growing of this to provide Government stock seed is firmly established. For the year 1943-44 the amounts of Government stock supplied to the seed trade were as follows:—

| | lb. | Value. £ |
|---|---|---|
| Government stock perennial rye-grass | 21,860 | 1,503 |
| Government stock Italian rye-grass | 29,800 | 1,539 |
| Government stock short-rotation rye-grass, H1 | 7,080 | 464 |
| | 58,740 | £3,506 |
| | lb. | £ |
| Government stock white clover | 10,782 | 2,830 |
| Government stock red clover (Montgomery) | 5,556 | 1,945 |
| | 16,338 | £4,775 |

Grand totals, grasses and clovers: 75,078 lb.; total value, £8,281.

Government stock seed of H1 rye-grass (short-rotation) has been distributed for the first time. Heavy demands for seed of this production are expected in future years, and to meet this the Agronomy Division at Lincoln is growing 8 acres of nucleus seed for next year. Altogether, of the several species, the Agronomy Division has 18 acres set aside for further increase of the nucleus seeds bred and selected at this station.

*Plot Trials and Strain-testing.*—This involves the preparation, sowing, management, and careful noting of some 3,600 plots each year. This means that approximately 2 acres have to be sown annually in small plots 1/2,000 acre in area.

*Field Trials.*—Field-strain trials in conjunction with the Department of Agriculture are being continued. Most of the present trials in operation are to test the value of short-rotation rye-grass in the field. Trials recently sown down include one at the Animal Research Station at Manutuke, Gisborne, and one on the Massey Agricultural College sheep-farm.

*Trials in Great Britain.*—The results to date on the R.A.S.E. trials have shown that New Zealand *certified* types will play a very valuable part in seed mixtures for use in lowland England. The fact that New Zealand uncertified types are of distinctly inferior value under English conditions has also been demonstrated in these trials. A further consignment of pedigree and certified seeds has been forwarded to England for the continuation and extension of this type of trial, which should do a great deal towards establishing our New Zealand selected strains on the English market.

## Field Ecology

(*a*) *Influence of the Animal in Pasture-production.*—This trial has now been terminated. The following figures give total dry-matter yields for the four-year period of the trial :—

| | Pounds D.M. per Acre. | Relative Yields. |
|---|---|---|
| No return of residues .. .. .. .. | .. 44,209 | 100 |
| Full return of residues .. .. .. .. | .. 58,497 | 133 |
| Return of dung only .. .. .. .. | .. 51,625 | 116 |
| Return of urine only .. .. .. .. | .. 50,122 | 113 |

It is a matter of considerable interest that the total extra growth obtained from the return of urine and dung individually tallies very closely with that obtained when returned together in the full-return treatment. The influence of a pedigree white clover throughout these trials has been very marked, and this has tended to equalize yields between no animal return and where the return of residues have taken place. Throughout the trial 4 cwt. superphosphate per acre was used.

(*b*) *Pasture-measurement Technique.*—Three systems of pasture measurement have been employed :—

(1) The system of small self-contained paddocks rotationally grazed and measured by motor mower strips prior to grazing :

(2) Small replicated plot system within a common enclosure where the animal residues are collected and are then returned to each plot in proportion to the amount of herbage produced by each plot :

(3) Small replicated plots within a common enclosure where the stock residues are returned indiscriminately over the plot series within the enclosure.

Each technique system has presented difficulties, and a good deal more work is required on " technique " work before reliable small-scale trials can be devised.

(*c*) *Production Trials of Station-bred Pasture Types.*—These have been conducted to guide the plant-breeder and to demonstrate bred material under comparative broadcast trials under the influence of the animal. Highly interesting and significant figures have been obtained from the early production and relatively good persistency of the hybrid rye-grass strains.

These strains serve as a basis for technique trials, and interesting results are forthcoming relative to persistency under varying technique management. The trials to date show that much greater care is needed in grazing or in utilizing the shorter-lived hybrid strains of rye-grass as compared with the true perennial. The latter will withstand very much harder pruning than the hybrids, which tend to be eliminated rapidly under severe defoliation, particularly towards the end of their growth period in late spring.

These results are of high significance to the plant-breeder at this stage in the evolution of a short-rotation rye-grass and other bred strains.

(*d*) *Western Wolths.*—A new trial has been laid down to test the winter productivity of roughly selected Western Wolths rye-grass against pedigree Italian rye-grass, short-rotation rye-grass, and green oats. It is felt that before much breeding-work is done with Western Wolths rye-grass that the above winter production trials be carried out to see just what place Western Wolths will occupy in temporary winter pastures or cover-crop work.

(*e*) *Sheep-nutrition Area, Massey Agricultural College.*—The original strain trial has been ploughed and the area resown to two classes of rye-grass pastures that are to be managed in two different ways : (1) continuous grazing, and (2) rotational grazing. The two pasture series are to test what improvement, if any, can be effected in grazing-management and fat-lamb production by adding the new short-rotation rye-grass to the mixtures. The two mixtures sown are as follows : (1) pedigree perennial rye-grass, 40 lb. ; (2) pedigree perennial rye-grass, 20 lb., plus short-rotation rye-grass, 20 lb. Three pound of pedigree white clover has been included in both mixtures.

*Manurial Trials :* These are being continued, including measurement yields of pasture by frame enclosures. The significant feature of these trials to date is the relatively insignificant difference between 1 cwt. super. per acre and 4 cwt. super. per acre and the marked difference where lime is used in addition to the superphosphate. The following figures are relative yields : 1 cwt. super., 100 ; 4 cwt. super., 101 ; 4 cwt. basic slag, 105 ; 4 cwt. super. plus lime, 113 ; 4 cwt. super. plus lime and potash, 112.

(*f*) *Silage.*—Some 200 tons of silage has been made in fourteen pits and stacks varying in capacity from ½ ton to 50 tons. The work of other years has been repeated in an effort to establish norms over a number of seasons. Last year's results go to show that the loss in dry matter is still between 40 per cent. and 50 per cent., with the exception where acid was used, and the loss here is reduced to 7 per cent. in small 3-ton silos and 20 per cent. in 25-ton silos. The addition of whey or molasses has not reduced the dry-matter loss. Feeding trials were conducted of raw material and of the material after ensilation. The chemical analytical work relative to this investigation was done by the Chemical Laboratory.

(*g*) *Fodder and Cover Crops.*—Some preliminary work was attempted with cover-crop production, but the season was too wet to give comparative results. Feeding trials to determine digestibility and yield of strains of fodders were conducted at Palmerston North and at Lincoln in collaboration with the Agronomy Division. These crops include chou moellier, thousand-headed kale, Giant rape, and B.L.E. rape. Three acres of chou moellier (three strains) and thousand-headed kale were sown, tended, and weighed on the dairy-farm with a view to determining time of sowing in relation to summer production

of forage. Four sowings were made between 10th October and end of November. The outstanding feature in the summer grazing was the decided preference for the chou moellier over thousand-headed kale and for the more mature crops over the more immature ones.

The stems have been left and new growth is coming away for late winter feed.

(*h*) *Herbage Dissection.*—This service has been continued and the work continues to increase.

### Aerodrome-turf Production

During the year full attention has been given to the grassing and maintenance of grass surfaces on about ninety aerodromes. Continuous attention to seeding, manuring, mowing, drainage, and general management has been responsible for the marked improvement in the flying-field surfaces. Despite heavy and concentrated wear on the fields at flying-training schools, the surfaces are less frequently unserviceable than they were a year or two ago, thus less training-time is lost.

The most outstanding feature of the work has been the great part artificial nitrogenous fertilizer has played in making it possible to grow grass satisfactorily, irrespective of soil type and climatic factors.

Considerable data have been accumulated during the year for compilation of a treatise dealing with the grass-turf aerodrome.

### Greenkeeping Research

The research area at Hokowhitu has been well maintained, and the results are now finding ready acceptance by most clubs where fine-turf greens are demanded.

### Soil Conservation

Active collaboration is being given Catchment Boards and Soil Conservation Committees relative to the part grasslands must play in soil-conservation programmes.

A scheme for hill-country research in the Manawatu Catchment Board's area has gone forward to the Council. Proposals for a set-up in the Whangamomona district have also been furnished.

The regrassing of secondary-growth trials conducted there twenty years ago still give a good lead to regrassing that difficult hill country.

### Regrassing eroded Pumice Country, Waiouru

At the request of the Army Department and in conjunction with the Public Works Department, officers of this Division have been called upon to combat serious erosion of extensive areas over which heavy military equipment had been operating. Good results have followed grassing down with brown-top, Chewing's fescue, and *Poa pratensis* as the base of a mixture bulked up with second-quality seed of annual and perennial species to give a quantity per acre which could be sown through a broadcasting-machine. Some experimental work with different species of grasses and with different fertilizers is being carried out on the several soils in this large block of country. The results to date indicate that for successful grassing the following are of importance :—

(1) Time of sowing : Spring sowing or late summer sowings are best :
(2) The choice of species is most important. Brown-top, Chewing's fescue, and *Poa pratensis* are the desirable permanent species :
(3) Nitrogenous fertilizer—*e.g.*, ammoniated superphosphate—applied at the time of sowing is essential in order to bring about rapid establishment of the sown species and provide a dense growth capable of withstanding frost lift the following winter.

### Pollen for Medical Institutions

The service of supplying grass pollens to various medical institutions for hay-fever prophylaxes is being continued, and a total of 614 grams of pollen was supplied.

### Vegetable-production

Supplies of vegetables for experimental dehydration processes have been produced for the Chemical Laboratory.

### Substation, Gore

It has been decided to set up a substation at Gore, and preliminary arrangements are well in hand.

### Substation, Lincoln

The set-up at Lincoln has been considerably improved and trials can now be placed on a comparable basis with Palmerston North. Strain-production trials, technique trials, influence of the animal on pasture-production, and seed-production trials with cocksfoot are a feature of the work there. The full collaboration of the Agronomy Division is greatly appreciated.

### Meteorological Station

The recordings are being considerably extended and considerable time daily is given to these.

## PLANT DISEASES DIVISION

Director : Dr. G. H. Cunningham

### I. Plant Diseases Investigations

(*a*) *Bacterial-wilt of Beans.*—Bordeaux and Cuprox (copper oxychloride) sprays gave adequate control of bean-wilt in field-scale plots. Four applications of 3–4–50 Bordeaux reduced infection from 76 per cent. to 2·7 per cent. ; and Cuprox (5 per cent.) gave comparable results.

Resistance trials were carried out with 137 lines comprising approximately 70 varieties. Results showed that (1) all white-seeded varieties are highly resistant to bean-wilt and also anthracnose ; (2) all runner varieties are rarely seriously infected on the pods, though foliage may become moderately attacked ; (3) several coloured-seed varieties are highly resistant, especially Hawkesbury, Canadian Wonder, Pinto, Pink, Tennessee Greenpod, Ne Plus Ultra, and many strains of Refugee.

(*b*) *Carrot Rust-fly.*—Work has been continued on the seasonal cycle and has confirmed previous findings that there are three main emergence periods in the year—namely, September–October, end of December, and end of February. A fourth probably occurs towards the end of April.

(*c*) *Vegetable-weevil.*—The life-cycle and seasonal-cycle of this pest has been worked out, and results are now ready for publication.

(*d*) *Pittosporum psyllid.*—Similar work has been completed on this pest, which attacks hedges of Pittosporum. Results are ready for publication.

(*e*) *Stored-grain Pests.*—At the request of British authorities, tests were made of inert dust developed in England to protect stored grain from weevil attack. Although chemically inert, such dusts kill by promoting evaporation of moisture from the insect body. Tests were made of its effects on bean and wheat weevils at concentrations of 1 part to 1,800 parts of beans and 1–1,000 of wheat. The dust proved most effectual; but it is considered unnecessary to employ such a product, since a Dominion-wide survey showed that in general stored grain suffers so little damage from insect attacks that costs of incorporating the dust are not warranted.

(*f*) *Citrus-canker.*—A further outbreak occurred in Tauranga, necessitating destruction of infected citrus trees in an area where eradication measures have not been forced. It is now three years since the last outbreak was reported from Kerikeri, showing that adequate control of this serious disease can be secured by eradication of infected orchards.

(*g*) *Linen-flax Diseases.*—A survey of South Canterbury areas was made early in 1945. The only disease noted was rust, which was prevalent in some late-sown crops. Specimens from Otautau infected with true browning were sent in from one commercial crop. Infection was confined to a few scattered etiolated areas in the crop.

(*h*) *Eye-spot of Wheat.*—Following a rapid survey in North and Mid-Canterbury, this disease was found only in Lincoln, these confined to a few plants in a small experimental plot at the farm of the Wheat Research Institute.

(*i*) *Vegetable Diseases.*—A co-ordinated scheme for control of diseases in Services' vegetable-production areas under control of the Department of Agriculture was worked out during the winter of 1944. One week of intensive training was given at the Division's headquarters to eighteen men in charge of these areas.

(*j*) *New Pests and Diseases.*—A serious pest of vegetable crops overseas, *Nezara viridula*, was collected at New Plymouth last April.

Larvæ of one of the white-fringed beetles, possibly *Pantomorus leucoloma*, was found in Hastings attacking roots of ornamental plants. The beetle is a pest of economic crops overseas.

A serious overseas rust of raspberry, *Phragmidium rubi-idaei*, was collected in Palmerston North last year and has since become widespread in that locality.

(*k*) *Tomato-streak.*—Infected specimens were forwarded from Hutt Valley, Wanganui, and Cheviot, in which localities the disease has caused heavy losses. Inoculations with the pure virus have shown the disease to be identical with Lycopersicum Virus I of Smith 1937.

(*l*) *Yellow-leaf of Phormium tenax.*—Preliminary investigations into the cause of this disease have been initiated. A brief survey of Moutoa area, in the Manawatu, has shown that incidence varies from a trace to as high as 85 per cent. Some varieties of flax would appear to be more susceptible than others, but none is immune.

(*m*) *Fruit-tree and Small-fruit Diseases.*—See Fruit Research Report, p. 16.

## II. Therapeutant Testing

(See also Fruit Research report, p. 16.)

*Soil Treatments.*—Further investigations have been carried out with use of chloropicrin. This chemical controls soil nematodes, damping-off fungi, and verticillium-wilt. Commercial methods have been devised for treating soils. Trials have been extended to tomato glasshouse soils and have shown that marked improvement in yield follows control of nematodes.

A new product, D.D. (a mixture of dichloropropane and dichloropropylene), has given results comparable with chloropicrin. D.D. is cheaper and less objectionable to use, so should prove of considerable value when available in commercial quantities.

Several cases of injury to Canterbury tomato crops were reported consequent on growers using as a soil treatment commercial formaldehyde which had deteriorated in the containers with formation of paraformaldehyde. Not only did such a product fail to control verticillium-wilt, but also caused injury to young plants.

## III. Timber Preservation

(See Timber Protection report, p. 6.)

## IV. Pomology Investigations

(See Fruit Research report, p. 16.)

## V. Miscellaneous

(*a*) *Lucerne Culture.*—Cultures have been supplied to 1,400 farmers sufficient to inoculate 188,700 lb. of lucerne seed, an increase of 19,200 lb. over last season's supply and nearly 40,000 lb. over that of 1942–43 season.

(*b*) *Rot-proofing of Fabrics.*—A large series of investigations has been completed and a suitable technique evolved for testing various chemicals used to protect canvas fabric against decay caused by fungi and bacteria, and effects of weathering upon them.

The process has also been employed to test effects of chemicals used to proof cotton and linen thread used in canvas and boot manufacture and cordage used in shipping, &c.

(*c*) *Control of Flies and Cockroaches.*—Effects of D.D.T. in control of flies in meat-works was investigated in the North Island. A team of American servicemen from the Pacific war zone carried out work of applying the product, and the Division has made periodic inspections of results. Promising control has been secured, D.D.T. after one application being still effectual after a time interval of two months.

Tests were also undertaken with D.D.T. for control of cockroaches in infested hotel and camp kitchens. Applied as a 5 per cent. dust in clay, adequate control was secured.

(*d*) *Penicillin.*—Preliminary work is being undertaken in production of small experimental quantities of penicillin from cultures of the fungus *Penicillium notatum* secured from British and American sources. The standard technique employed in testing for percentage yield has been used in the laboratory. Work is also proceeding to ascertain the effects of this and other antibiotics in control of plant pathogens, and in endeavouring to ascertain if any of the latter produce such substances.

(*e*) *Experimental Farms.*—Owairaka: Work during the year has been handicapped by staff shortage. A new insectary was completed during the year, and is being used in timber-protection investigations. Work is being commenced on a further lean-to type glasshouse. The unusually wet season has favoured growth of fruit-trees and shelter-belts, but has increased the amount of work required to keep weed growth in check in the numerous experimental plots. Approximately 50 tons of manure were secured from a city racing stables; part was used for manufacture of compost required for glasshouse soils, the remainder incorporated in lighter parts of the farm soils with marked benefit. Both areas are handicapped because of lack of a suitable tractor, so that most cultivation has had to be done with a rotary hoe, which, though suitable for small areas, is inadequate for present farm requirements.

Oratia: All young plantings of apples, citrus, and peaches are making excellent growth. Drainage of main blocks has been completed. Pipes have been laid from the stationary spray plant so that new plantings can be sprayed. Establishment of new shelter-belts will be completed during the winter.

## SOIL SURVEY DIVISION

Soil survey investigations are undertaken by the Soil Survey Division (Dr. L. I. Grange, Director) and by the Cawthron Institute (Sir Theodore Rigg, Director), (see p. 40).

### Soil Survey Division

*General Survey, North Island.*—As a result of further surveys it has been possible to add corrections to the soil map of the North Island. The maps are now being printed. An article entitled "A Basic Scheme for Land Classification" published in the *Journal of Science and Technology* contains information on the lime requirements and general fertility of the North Island soil groups and indicates what further surveys are required to produce a satisfactory land classification.

*General Survey, South Island.*—In the South Island the chief districts which have been mapped for general survey purposes are Marlborough and the West Coast. In Marlborough the area between the Awatere River and Ward and extending from the coast up to the margin of the high country was covered and the broad soil types separated. The soils are podzolic. The chemical analyses show that the soils are fairly well supplied in lime, but are very low in phosphate except on the terraces of Awatere River near Seddon.

In the Westland district the principal soil types of the valleys of the Grey, Teremakau, Arahura, Hokitika, and Totara rivers and intermediate coastal areas were mapped on a scale of 4 miles to an inch. The most important soils agriculturally are the river flats, and these cover approximately 70,000 acres. Unlike many of the river flats of the east coast and of the North Island, they are deficient in lime and need about 2 tons per acre. The available phosphate in these soils is generally high. There are approximately 350,000 acres of terrace land in Westland and the soils are all strongly leached—50,000 acres are well-drained soils which need heavy dressings of lime and light dressings of phosphate; the remaining 300,000 acres is wet pakihi land which needs drainage in addition to heavy applications of lime and phosphate. These are problem soils. Minor elements are also likely to be in short supply on these leached soils.

*North Auckland.*—A set of ten maps covering North Auckland Peninsula on a final scale of 2 miles to 1 in. are being prepared for publication and are being drafted by the Public Works Department, Whangarei.

A complete legend covering the types used has been prepared and parts of the bulletin sketched out.

*Whangarei County.*—A map of the county on a scale of 1 mile to the inch has been prepared for publication.

A holdings map on the same scale has been prepared from county data. Both these maps have been used by Dr. Hamilton as a basis for producing his various land-utilization maps.

The writing of the Whangarei bulletin, which will be published in co-operation with Dr. Hamilton, is well under way.

*Mid Hawke's Bay.*—A bulletin dealing with the soils of mid Hawke's Bay is in course of preparation.

*Geraldine County.*—The detailed survey of the alluvial soils of the Geraldine County was extended from the southern border north to the Orari River. The soil pattern is complex and mapping necessarily very detailed. The soils are derived from a mixture of loess and greywacke waste and include some of the most fertile soils of South Canterbury.

*Ellesmere County.*—Field mapping on a scale of 40 chains to the inch and analyses of the main soil types have been completed in the Ellesmere County. The soils are alluvial and resemble somewhat those of Geraldine County.

*High Country of the South Island.*—The bulletin on soils and erosion in the high country of the South Island is in the press and will be issued within a few weeks.

*Soil Erosion Experimental Plots in High Country.*—Further experimental plots to determine the effects of spelling, and to observe the results of sowing introduced plants, were established in the high country. Three of these were sown with a selection of introduced grasses and herbaceous plants supplied by the Botany Division. Careful analyses have been made of specially selected soil samples from the plots, and these should form the basis for assessing in five or ten years the changes conservation practices have induced.

*Soil Erosion, South Canterbury Downlands.*—A survey for the South Canterbury Catchment Board has been commenced of the erosion following ploughing of the steeper portions of the Downlands.

*Linen Flax.*—In association with the Botany Division an investigation was made into the relationship between soil background and quality and yield of linen-flax fibre. This work, which concerned Geraldine County principally, was completed for the 1943–44 season and a report prepared.

*Great Barrier Island.*—A survey of the soils of the Great Barrier Island and a report prepared for the Minister of Rehabilitation. The island was found to contain approximately 8,000 acres of ploughable land which could be developed for dairying, 20,000 acres which could be developed for grazing, and 30,000 acres which should be preserved in forest. At present about 1,500 acres are used for dairying, 24,000 acres for grazing, while the remainder is in forest, scrub, and swamp vegetation.

Many of the soils of the island are eroded, this being due mainly to frequent scrub fires. Most of the soils require heavy applications of lime. There is no limestone on the island.

*Agricultural Development, Southland.*—A general survey of 150 square miles of the Southland Plains to the east of Invercargill was made at the request of the Public Works Department. This survey covered only the broad soil pattern and delineated soils suitable for development.

*Irrigation, Ashburton County.*—In the Ashburton County six border-dyked paddocks which will be irrigated next summer have been carefully sampled to determine their fertility status. This will give a reliable basis for observations on chemical and fertility changes under the irrigation water.

*Saline Soils.*—Further samples have been analysed from the Kaipara Harbour reclamation scheme and Timaru Airport. In both cases there has been little improvement in the more saline patches. An area near the Waimakariri, Canterbury, was investigated for the Disabled Soldiers' Re-establishment League. The salt content of the soil is too high to enable basket willows to be grown successfully.

*Kerikeri Citrus Orchards.*—Complete soil and leaf analyses were made from citrus areas at Kerikeri. The soils showed low lime, while the effects of top-dressing were reflected in lowered potash and magnesium compared with roadside samples. The magnesium figure was low enough to suggest the trial of magnesium compounds as top-dressings. Leaf analyses also indicated that magnesium should be tested, but none of the data was conclusive enough to be certain that this was a primary cause of lowered production.

In co-operation with the Plant Diseases Division and the Horticulture Division, experiments were laid down on two orchards. These were designed to gauge the response of orange and lemon trees to magnesia, manganese, zinc, and molybdenum.

*Pacific Islands Soils.*—Advice has been given to other Departments on the plant-food content of soils received from Pacific islands. An article has gone forward for publication on the laterite soils of New Caledonia.

*Dunging and Urine Plots, Lincoln.*—In co-operation with the Grasslands Division the soil laboratory is following the changes induced by the return and non-return of dung and urine to pasture at Lincoln.

*Glasshouse Soils.*—At the request of the Horticulture Division an investigation was made of glasshouses where yields were decreasing. Analyses indicated that potash had been used greater than optimum amounts. Shortage of staff precludes expansion on problems such as these, but there is no doubt that much work of a detailed nature could profitably be done in this field. Probably nowhere else does man change the nature of the soil so quickly and in different ways. Each soil has to be considered individually.

*Compost.*—At the request of the Internal Marketing Division we have investigated the large-scale composting of vegetable wastes, particularly cabbage. This material is difficult to handle, in that it is attractive to flies and easily waterlogs in the bins because of the high water content (90 per cent.). From pilot experiments suggestions have been made for the large scale bins. Free drainage and good aeration are called for, and if this is supplied cabbage is capable of breaking down very quickly.

*Pot Work.*—Pot work has continued during the year in using Virginia stock to evaluate the fertility of soils sent from different parts of New Zealand. A search for a better phosphate-indicator has led to cress being used on large-scale experiments, and data from these are now being assembled. In collaboration with Miss Cocks Johnston, exhibits have been prepared for the Health Department mobile shows. Pot exhibits have illustrated the need for lime and phosphate, and the difference in natural fertility of the various soils in New Zealand.

*Soil Tilth.*—An investigation has commenced to evaluate in physical terms good and poor tilth. A deteriorated farm in South Canterbury has provided a good starting-point for testing methods of measuring tilth and pore space. Such data is likely to be of fundamental importance in assessing methods of bringing back to good tilth soil that has deteriorated through overcropping. Parallel with the physical investigation a start has been made to fractionate the humus from good and poor phases of the same soil type.

*Fluorine.*—Analyses for fluorine from the main soil types has continued. By comparison with American data, New Zealand soils would appear to have an average content of fluorine.

*Soil Mechanics.*—Among the investigations undertaken this year have been—

(1) *High Bank, Ashburton.*—An embankment had failed on saturation with water due to a high air voids content. After investigation a better grading of material of high density was suggested :

(2) *Nihotupu Dam.*—Partly as the result of the investigations mentioned in last year's report, a tender was accepted for the construction of a rolled fill earth dam. The specifications for the contract include soil mechanics data and represent a big step forward in the application of laboratory data for engineering construction. Work is in progress in deciding how far deviation from the specifications can be allowed for safety :

(3) *Turakina Tunnel.*—Among the possible methods of stabilizing running sand behind the tunnel is chemical stabilization. This involves forming an artificial silicate in the sand through pumping chemicals into it. Small-scale experiments were in line with experience overseas that running sand could be stabilized this way, and while the method was not put into actual practice data is now available should the occasion arise again :

(4) *Waipori Dam.*—Investigations were made of borrow-pit material for an earthen causeway :

(5) *Lake Kimihia.*—Tests have been made at the request of a private contractor on the site of a proposed opencast mine. Advice was wanted on a safe batter for the cut to the coal and the likely permeability of the stop-bank material that was to hold back the lake from the workings :

(6) *Breastwork at a Naval Base.*—Samples were obtained from the harbour bottom for calculating earth pressures against sheet piling of a breastwork:

(7) *Housing.*—At the request of the Housing Department tests were made of the permissible loading for safety for the foundations of a community centre.

*Work for other Departments.*—Practically all projects mentioned above except the general surveys and the detailed soil mapping of districts were carried out for other Departments or branches of this Department. Some additional tasks are mentioned below:—

Report on the soils of Huntly district for the Organization for National Development; advice to the Department of Agriculture and Lands Department on the development of several blocks; report on the soils of Mangonui area in relation to forestry for Forestry Department; soil maps and lime requirement of several Native development areas for the Native Department; notes supplied concerning soil conditions both to the Education Department and to the Auckland Education Board on various sites for the proposed agricultural high school in North Auckland; report on Kaingaroa flax area for Industries and Commerce Department; soil maps for the Valuation Department; a report for the Public Works Department on the lagoon area adjoining the Wairarapa Lake in regard to the suitability of the soils for drainage; and a survey of aerodromes for Aerodromes Branch of Public Works Department.

## TOBACCO RESEARCH

*Advisory Committee.*—Sir Theodore Rigg (Chairman), Messrs. F. R. Callaghan, L. J. Schmitt, H. L. Wise, W. K. Dallas, N. J. Adamson, E. M. Hunt, C. C. Nash, F. A. Hamilton, B. Jenkins, N. Rowling, and R. Thomson (Director of Station).

During the past year four meetings of the Tobacco Research Committee have been held to consider programmes of work and reports presented by officers associated with tobacco research, and to advise on policy matters connected with the development of the tobacco industry and the progress of the Research Station.

A small kiln was erected for experiments in fire curing tobacco. A new soil-sterilizing plant was installed during the season. This consisted of a 12 h.p. steam boiler, together with concrete bins large enough to hold 40 cubic yards of soil at one time.

Climatic conditions during the past growing season were in the main abnormal. Temperatures during the spring and early summer months were much below the average, and even right through the season night temperatures were relatively cool. Sunshine was also less than usual. On the other hand, rainfall was unusually high, averaging about 5 in. per month. This was the first season on the Station that it was not necessary to resort to irrigation during the mid-summer period. It is anticipated that the yield will be about the average of previous seasons. The colour of the leaf is good, but the leaf is somewhat lacking in body. The 1943–44 crop was the heaviest so far produced, being 18,243 lb. from 14 acres, and was sold at an average price of 2s. 5d. per pound.

The new steam sterilizing plant proved a great success. In addition to the Station soil, 150 cubic yards were treated for private growers. This quantity would have been greater had the new boiler been obtained earlier in the season. Growers are increasingly realizing the benefits accruing from the use of steam-sterilized soil in the raising of healthy seedlings, and the indications are that the use of steamed soil will greatly increase during the coming season.

The research work this season, as in previous years, has been a co-operative effort carried out jointly by the staff of the Research Station and officers of the Cawthron Institute. The Research Station has concentrated on the field side, which has included all types of fertilizer investigations, variety trials, seed-production work, plant-breeding, and mosaic investigations. The Institute work has included tobacco-disease surveys, investigations into the control and spread of various diseases, chemical studies dealing with the intake of plant nutrients, the chemical composition of cured leaf, and chemical analysis of leaf from the field trials at the station. The soil survey of the Waimea Plains has been continued with a view to the expansion of the tobacco industry.

### Fertilizer Experiments

In considering the results from the fertilizer experiments from the 1943–44 season it should be borne in mind that the season under review was very dry during the early summer, followed by heavy rain which caused surface flooding. Where the quantity of fertilizer per acre was varied by 200 lb. intervals from 800 lb. to 1,400 lb., 1,200 lb. per acre gave the best return. The additional fertilizer appeared to increase leaf size, while quality remained fairly uniform throughout. Although 1,400 lb. gave a further increase in yield, it was not sufficient to offset the additional cost of the fertilizer. These results confirm those of previous seasons, and support last season's recommendation of 1,200 lb. per acre for soils of the Station type. In a new experiment dealing with varying percentages of nitrogen and potash in the fertilizer there were no outstanding differences, although the general tendency of heavier growth with increasing quantities of nitrogen was evident. The higher proportions of potash were responsible for smoother leaf.

Where different types of phosphate were applied at the same rate per acre a difference was recorded for the first time, superphosphate outyielding both basic super. and serpentine super. The addition of dolomite had a beneficial effect on both yield and quality. In the rotation experiment comparing continuous tobacco with tobacco following rye-corn ploughed under, there was no significant difference in yield or quality.

Where different methods of applying the fertilizer were tried out, the heaviest yield was obtained by placing all the fertilizer in the furrow before planting. The usual method of applying half the fertilizer in the furrow and broadcasting half shortly after planting (which has proved the best in previous seasons) gave the next highest returns. The plots receiving the fertilizer in side bands were slow to come away, and although they made up some of the difference they were definitely lower in yield. This was confirmed on a field scale using a commercial fertilizer drill.

In an experiment where nitrogen was supplied in various forms the results were in striking contrast to those of the previous season. In the dry season under review the most readily available forms, particularly nitrate of soda, gave the best results combined with high-quality leaf, whereas under the wet conditions of the previous season the organic forms of nitrogen produced the best yield and quality.

This demonstrates the necessity of using mixed nitrogen in the fertilizer to meet varying weather conditions. In a further experiment half the fertilizer was applied under the plant, while the remaining half was applied at intervals during December and January. It was found that delaying this second application later than mid-December resulted in a reduction of both yield and quality.

Results of a spacing experiment confirmed those of previous seasons. With rows of a standard width, 3 ft. 6 in., a 2 ft. spacing of plants gave the best results both of yield and quality.

On an area to demonstrate the effect on the plant of the absence of the chief plant-food constituents from the fertilizer mixture some striking results were obtained. Absence of nitrogen resulted in very low yield. Absence of potash did not affect the yield, but produced leaf of very poor quality. Leaving out the phosphate resulted in a very slow early growth, but apparently ample reserves in the soil finished off the crop quite well. The best yield and quality was obtained from the mixture containing low calcium.

The results for the 1944–45 season will not be available until after the leaf is graded, but the following observations on the growth of the plots give some indication of the general trend. The continued heavy rain was responsible for leaching out much of the fertilizer, and in many instances differences were not very pronounced. The growth of the crop increased somewhat, but not outstandingly, as the quantity of fertilizer was increased up to 1,400 lb. Increasing the percentage of nitrogen resulted in a greater growth of leaf, but under the weather conditions prevailing did not delay maturity unduly. Extra potash resulted in a smoother, better-bodied leaf. No apparent difference was noticeable from the use of different types of phosphate. There was a suggestion that tobacco after rye-corn was better than tobacco from the continuous tobacco plots. In the placement of fertilizer once again the plots receiving the fertilizer in side bands were slow in coming away, indicating that at least some of the fertilizer must be within easy access of the roots. Where different forms of nitrogen were tried out the readily available forms appeared to stimulate early growth.

### Intake of Plant Nutrients

Studies on the intake of plant nutrients by flue-cured tobacco have been continued. During the present season tobaccos grown on two soil types, a medium sand and a light phase silt loam, were studied. On both soils, plants of Harrison's Special variety grown in the seedling-beds at the Tobacco Research Station were used for the experiments. The object of the experiment was to ascertain at comparable dates the rate of growth of the plants on the two soils, and to determine for these dates the intake of nutrients by the crop. So far the yield data only are available. These show that on the medium sand of the Tobacco Research Station the maximum weight of dry matter was 1,614 lb. per acre at the sampling of 7th February—the plants on that date averaging 15·9 per cent. of dry matter. On the heavier soil the maximum figure for dry matter was 3,000 lb. per acre, obtained, however, later in the season. On the 7th February the dry-matter yield from the heavier soil was 1,852 lb. per acre, the plants averaging only 13·8 per cent. of dry matter. The higher content of dry matter in the tobacco grown on the sandy soil was noted at all stages of growth of the plants until maturity was reached.

### Magnesium Deficiency

Finely ground dolomite and magnesite were again employed in three field trials on soils known to be low in magnesium content. Despite the rather wet season, typical symptoms of magnesium deficiency did not appear until late in the season, and then only on one of the experimental areas to any marked extent. The use of dolomite or magnesite improved the texture of the leaf on the area most affected by magnesium deficiency.

### Chemical Composition of Tobacco with different Fertilizer Treatment

Mineral analysis of tobacco samples from the fertilizer trials at the Tobacco Research Station during the 1942–43 and 1943–44 seasons have been completed. The results show that omission of potash and nitrogen from the fertilizers leads to reduced amounts of these plant-foods in the cured leaf on the sandy soil of the Research Station. When the nitrogen content of the fertilizer was increased, the content of nitrogen in the cured leaf did not always rise consistently. Although the use of potash in fertilizers was reflected, in general, by an increased content of this constituent in the cured leaf, there was a limit beyond which increase of potash in the fertilizer resulted in little further increase of potash in the leaf.

Wide spacing of tobacco plants in the field tended to increase the nitrogen content of the cured leaf without affecting significantly the content of mineral constituents.

Much time has been devoted to estimations of reducing sugars and sucrose in the tobacco samples obtained from the Research Station. In the 1943–44 season the sugar contents were higher than those for the previous seasons. It would appear that seasonal conditions during the growing and harvesting of the tobacco exert an important influence on the sugar contents of the cured leaf. An interesting feature of the analyses of tobacco samples obtained from Tapawera was the high content of magnesia in the samples. In one sample the magnesia content attained the high figure of 4·5 per cent. MgO on the dry matter. The high magnesia figures of the Tapawera samples were associated with reduced contents of lime and potash.

### Seed-bed Experiments

These experiments were designed to serve two purposes: to study the effect of various soil treatments and seed-bed practices on the incidence of mosaic in the field, and to provide information on the value of various bed treatments on the raising of seedlings. Steam-sterilized soil proved superior to unsteamed, the plants from the steamed soil not only being larger and more forward, but also having a relatively larger root system. As regards fertilizer, ½lb. tobacco fertilizer per square yard proved the best for steamed soil, while on the unsteamed the optimum appeared to lie between ½ lb. and 1 lb. Various chemicals were tried as soil disinfectants, but too short a time was allowed to elapse between treatment and sowing, and all chemicals showed a retarding effect on growth. The standard fertilizer containing 3 per cent. nitrogen proved superior for the raising of plants to mixtures containing more or less nitrogen. Increasing the percentage of nitrogen resulted in a decrease in the proportion of root weight to leaf weight.

## Disease Investigations

(*a*) *Angular Leaf-spot.* In view of the identification of angular leaf-spot in several tobacco gardens last season, a close inspection was made of the seedling-beds of those growers where the disease had been observed. The seedling-beds of twelve growers in the Dovedale, Stanley Brook, and Pangatotara localities were closely inspected and in four cases slight to moderate infection was found. Arrangements were made for the spraying of these beds with Bordeaux.

Late in the season a field inspection covering fifty-three tobacco gardens distributed in different parts of the tobacco-growing areas was made. The survey showed a rather wide distribution of angular leaf-spot in the Riwaka and Motueka districts, Dovedale and Stanley Brook being comparatively free from this disease. Of the fifty-three gardens inspected, ten were healthy, nine were rather badly infected, and the remainder showed slight to moderate infection. No doubt the wet season which continued into the harvesting of the tobacco leaf assisted very materially in the spread of this bacterial disease.

(*b*) *Black Root-rot.*—A careful watch for black root-rot, which causes a stunting of tobacco plants, was maintained during the season. Several fresh cases of poor growth caused by this disease were identified.

(*c*) *Collar-rot.*— The seedling-bed experiments for the control of *Sclerotinia* have been continued. In addition to semesan, bluestone, formalin, and zinc oxide, chloropicrin was tested on seedling-beds which previously had been heavily infected with *Sclerotinia*. In several cases there was a severe retardation of the growth of the tobacco seedlings as a result of using the chemicals. In no case was an entirely satisfactory control obtained, but both bluestone and chloropicrin showed a considerable reduction in the amount of infection on the tobacco seedlings.

(*d*) *Mosaic Investigations.* —These have comprised a survey of mosaic in typical gardens throughout the tobacco-growing districts and a continuation of seedling-bed experiments with a view to securing more information on the incidence and transmission of mosaic:—

(1) Survey of Mosaic in Tobacco Gardens: An examination was made of five lots of two hundred plants in the tobacco gardens of twenty-one growers located in Dovedale, Motueka, and Riwaka. The survey showed a great reduction in initial mosaic over the position in the previous season, the average percentage being 8·7, compared with 37·1 in the 1943–44 season. For seven growers in Dovedale the average figure was 5·8 per cent. initial mosaic, as against 24·5 per cent. for the previous season. For six growers in Motueka the average figure was 9·5 per cent., compared with 57·7 per cent. in the 1943–44 season; while for eight growers in the Riwaka locality the percentage was 9·5 per cent., compared with 33 per cent. in the previous season:

(2) Influence of Soil Disinfectants and Fertilizers on the Incidence of Mosaic in the Field: In view of the known value of steam-sterilization of seedling-beds in reducing the amount of mosaic, several soil disinfectants were tested on unsteamed soil with a view to ascertaining their value in mosaic control. Formalin, urea, and chloropicrin were used in these experiments. Unfortunately, applications were made too late in the season, and in several cases harmful effects on the tobacco seedlings were brought about. As far as the experiments have gone there is some indication that both formalin and urea are valuable in reducing the amount of mosaic in seedling-beds. Further confirmation has been obtained of increased mosaic incidence with liberal nitrogenous manuring of the seedling-beds.

Milk sprays used on the seedling-beds prior to the pulling of the plants did not give any noticeable protection against mosaic transmission when the plants were pulled by a worker whose hands were infected. On the other hand, milk and tannin sprays gave a high degree of immunity to seedling plants where a virus spray was applied after the milk and tannin sprays. The field treatments with fertilizers and variations in soil and crop management gave confirmation of results in previous seasons. The removal of tobacco stalks as against ploughing-in of stalks did not give any significant result. Continuous tobacco compared with tobacco grown in rotation was equally low in the amount of initial mosaic.

Increases in the amount of fertilizer mixture from 800 lb. to 1,400 lb. per acre, variations in the amounts of nitrogen and potash in the fertilizer mixture, and the omission of single plant-foods from the fertilizer mixture did not give any significant result in the amount of initial mosaic. In every case the amount of initial mosaic under field conditions was less than 5 per cent., seldom exceeding 2 per cent.

A valuable experiment showing the ease with which mosaic can be transferred by workers handling plants at different stages in the pulling and planting of seedlings in the field was arranged at the Tobacco Research Station. The following figures illustrate the great importance of observing simple precautions in the handling of tobacco plants:—

| | Mosaic, per Cent. |
|---|---|
| Control (clean hands) | 5·0 |
| Plants pulled with infected hands | 36·0 |
| Plants laid out with infected hands | 67·5 |
| Plants pulled after thorough washing of hands | 1·5 |

## Seed-production and Plant-breeding

The Research Station continues to supply manufacturers with seed for sowing the commercial crop. During the past season 36 lb. of seed were supplied, as against 16½ lb. and 17 lb. in the previous two seasons. Experience with the seed-production work emphasizes the necessity for once testing the single-plant selections before they are put into commercial use.

Plant-breeding to obtain mosaic-resistant varieties continues. Some of the crosses are segregated for resistance, but much work remains to be done before the desired flue-cured characteristics are obtained. Breeding-work to produce black root-rot resistant varieties was carried a stage further. The hybrid material was grown on infected ground and resistant plants back-crossed to the flue-cured parents. Two varieties resistant to black root-rot were received from United States of America and on a first season's trial on infected land have shown great promise.

### Fire-cured Tobacco

Quite an appreciable quantity of fire-cured tobacco is imported into New Zealand each year for manufacturing certain blends. As this tobacco is grown on a heavy soil type it offers a possible avenue for expansion of the tobacco-growing industry. Preliminary trials are being carried out at the Research Station this season. Three varieties were planted on a suitable soil type and are being cured over open fires in a specially constructed kiln.

### Kilns and Curing

Very little is known regarding what takes place in a kiln during curing, particularly with reference to variation in temperature and humidity in different parts of the kiln, circulation of air, &c. As a basis for further research into kiln practices, officers of the Dominion Laboratory spent some time at the Station taking measurements and observations of these conditions.

### Soil Survey of Tobacco Lands

Tobacco soil maps for the Appleby-Brightwater sector of the Waimea Plains have been prepared This area covers some 9,710 acres of alluvial land, of which 2,012 acres are texturally suited for flue-cured tobacco. Much of this land, however, falls into soil group 3, which requires favourable seasonal conditions to give optimum yield of tobacco.

During the past year another 7,000 acres of alluvial land lying between Brightwater and Spring Grove have been mapped. This area contains 1,389 acres belonging to soil groups 2 and 3, both of which are texturally suited to flue-cured tobacco. Over one-half of the land, however, falls into soil group 3, which in dry seasons would not give very satisfactory yields of leaf.

Owing to lack of staff it has not been possible to revise the tobacco maps showing the exact distribution of tobacco in the Nelson district, but a study of the acreages, applied for by growers, shows the following changes: 1944 season, 3,105½ acres; 1945 season, 3,367½ acres. The increase of tobacco acreage is associated mainly with the Motueka, Riwaka, and Wai-iti localities.

## WHEAT RESEARCH INSTITUTE

*Advisory Committee.*—Mr. R. J. Lyon (Chairman), Mr. C. E. Boon, Mr. F. R. Callaghan, Mr. J. Carr, Mr. H. E. Fairey, Mr. J. F. Frew, Mr. R. K. Ireland, Mr. A. Jones, Mr. R. McPherson, Mr. W. W. Mulholland, Mr. J. P. O'Connor, Mr. W. O. Rennie, Sir Theodore Rigg, Mr. P. W. Smallfield, Mr. P. R. Talbot. Acting Chief Executive Officer: Dr. O. H. Frankel. Chief Chemist: Mr. E. W. Hullett.

### Wheatgrowing

*Threshing Returns.*—The threshing returns for the 1944 harvest were analysed as usual. For the first time since it was first distributed, Cross 7 did not increase its acreage, but remained stationary at approximately 60 per cent. of the wheat area. Fife Tuscan, a wheat recently produced by the Institute, rose from 3·3 per cent. in 1943 to 7·3 per cent. in 1944, at the expense of Tuscan. The increased yield over Tuscan which Fife Tuscan had shown in the preliminary trials was again confirmed in these threshing returns. In the three survey districts in the Ashburton County where a total of 8,000 acres of Fife Tuscan was grown it yielded 4·8, 2·5, and 6·1 bushels per acre more than Tuscan.

*Sub-surface Broadcasting.*—A new sowing device for sub-surface broadcasting which has come on the market was again tested in field trials, at different rates of seeding, against a normal drill. In a trial laid down in Hunters there was a distinct and significant gain in yield through using the new coulter; in another trial, in Cross 7, there were no differences between treatments. It is concluded from these and previous trials that sub-surface broadcasting may increase yields, but that the circumstances under which this occurs are complex and unknown.

*Sprouted Wheat for Seed.*—The large proportion of sprouted wheat from the harvest of 1945 necessitated a rapid investigation into the laboratory and field germinations of wheat sprouted in different degrees. This study made possible recommendations being issued to farmers for the use of sprouted grain for seed-wheat.

### Wheat-breeding

*New Varieties.*—Of the advanced lines under test at Lincoln, 78, 01 (Tuscan × Tainui) continued to give good promise. It is now to be tested by the Fields Division in more widespread trials. A new wheat, 140, 014 (Cross 7 × Tainui), combines good agronomic characters—on the whole fairly similar to those of Cross 7—with the highest standard of baking quality. This variety should be especially valuable for the manufacture of wholemeal. This and similar lines will be tested in district trials.

*Genetic Research.*—Biometric and genetic investigations into the variation and inheritance of certain economic characters in wheat have been further advanced. A critical study into methods of selection was commenced. Cytogenetic work on certain aberrants in wheat was continued.

### Cereal Chemistry, Milling, and Baking

*Moisture Testing.*—As in previous years, testing facilities were made available to farmers, merchants, and millers at Palmerston North, Blenheim, Christchurch, Ashburton, Temuka, Timaru, and Dunedin. The Seed Testing Station at Palmerston North and the New Zealand Wool Manufacturers' Research Association at Dunedin assisted in their respective districts.

*Milling and Baking Tests.*—The unfavourable harvest of 1945 resulted in a very large number of samples being submitted by millers. The testing service has enabled large quantities of wheat to be used which would otherwise have been rejected for milling.

*Chemical Research Work.*—This has continued to suffer from the absence of members of the staff on war work, but chemical investigation of the baking process and the study of baking problems have been further advanced.

*Wheat-drying.*—A line of two hundred and sixty sacks of wheat which had been submerged during the floods and which contained 32 per cent. of moisture was saved from loss by subjecting it to ventilation through a system of simple wooden ducts placed on the floor of a store. A similar line left

in the farmer's field became unfit even for feed purposes. Most of the ventilated line was entirely fit for feed, and a portion of it which was mouldy was expected to be usable after machine cleaning. Even better drying effects could be achieved by a rearrangement of ducts which was suggested by the results obtained.

This experience demonstrated the feasibility of saving wheat endangered by accidents such as flooding and that the equipment can be quickly and cheaply improvised.

This trial was the outcome of experiments made in 1938 with wheat containing 18 per cent. of moisture, and in view of the success achieved this year it is intended to proceed further, but more especially in the treatment of lines of wheat with from 18 per cent. to 20 per cent. of moisture, a number of which are encountered in many seasons.

*Wheat Storage in Southland.*—Wheat-drying in Southland presents special problems owing to the lateness of the harvest season and the high air humidity. Observations on stacked lines and on wheat in open trays showed that the rate of drying in stacks on the farm is very low. Where the wheat cannot be brought into dry condition before the winter, it seems doubtful whether it is worth while attempting to decrease the moisture content by keeping wheat in stacks over the winter and early spring. It was found that drying-conditions were much more favourable in the Dipton-Winton area than in Invercargill.

### Nutritional Work

*Vitamin Content of New Zealand Wheat and Flour.*—Samples of the wheat used and the flour manufactured from many flourmills have been analysed for thiamin (Vitamin $B_1$). A series of samples from twenty mills received in the second half of 1944 showed that average thiamin content of the wheats was 4·5 micrograms per gram, while that of the flours was 1·5 micrograms per gram. In 1944, therefore, New Zealand flour had 50 per cent. more thiamin than British pre-war flour and half that of the present British national flour. Investigations aimed at raising the thiamin content of New Zealand flour are in progress.

*Milling of High-vitamin Flour.* It was previously reported that, at the request of the Department of Health through the Nutrition Research Committee of the Medical Research Council, the milling of high-vitamin flour on a commercial scale was to be attempted and that preliminary studies and analyses of mill products were in progress for that purpose. This work revealed, however, a much easier mode of approach to the problem and made inadvisable an immediate large-scale experiment. It was found that certain mill streams at present going to pollard contained a relatively large proportion of the total thiamin in the wheat, and that the thiamin was present not on the branny part of the pollard streams, but in products which could possibly be added to flour and which could be separated mechanically. The work was therefore centred upon the method of treatment of the pollard streams to facilitate the separation of the valuable portions.

A new milling-machine has been designed and its prototype used in a commercial mill for some weeks. Another improved model is now to be made with sufficient capacity to permit a full-scale trial.

Small-scale experiments have shown that the new method should enable the thiamin content of New Zealand flour to be raised to about double its present value. The yield of flour would be raised by 2 per cent. or 3 per cent. The effect of the additions on the breadmaking quality of the flour and on the crumb colour of the bread has been slight.

Part of the expense of the commercial trials will be borne by the Department of Health.

### Extension Work

As in previous years, the Institute has continued to collaborate with the Wheat Committee, with the organizations of farmers, millers, and bakers, with the Armed Forces, and with many individuals and firms in the industry. A number of addresses were given to various organizations. In the awkward harvest season of 1945 the advisory and testing activities—especially on behalf of flour-millers and bakers—have been called upon to a greater extent than ever before. The travelling baker continued to visit numerous bakers throughout the Dominion.

## CAWTHRON INSTITUTE

Director: Sir T. Rigg

Assisted by grants from the Department of Scientific and Industrial Research, the Cawthron Institute has carried out investigational work connected with soil survey, mineral-deficiency problems, and fruit and tomato research. In addition, the Institute has co-operated in the work of the Entomology Division of the Plant Research Bureau (see p. 28) which is located at the Cawthron Institute, and in collaboration with the Tobacco Research Station has been responsible for the conduct of work relating to the tobacco industry (see p. 36).

Other research work conducted by the Cawthron Institute is reported below under the headings Soil Survey, Tomato Investigations, Fruit Research, Cobalt Investigations, and Magnesium Investigations.

### Soil Survey

Soil-survey work has been curtailed owing to the absence of several members of the staff with the Armed Forces.

*Land Utilization.*—A land-utilization map covering the Brightwater - Spring Grove sector of the Waimea Plains has been prepared. Much of the land is devoted to arable farming with small acreages of tomatoes, hops, orchards, and tobacco.

*Chemical Work.*—The routine examination of soil samples collected in connection with the soil surveys of the Waimea Plains has proceeded steadily.

Further work has been done on the effect of steam sterilization and formalin treatment on the nitrogen status of Nelson tomato soil under glasshouse conditions. Both steam and formalin treatments resulted in a rapid increase in ammonia nitrogen. Nitrate nitrogen, on the other hand, was at a lower level than in the untreated soil. On the 11th August the figures for ammonia nitrogen were: formalin, 29·8 p.p.m.; steam sterilized, 35·1 p.p.m.; and for untreated, 18 p.p.m. On the

3rd October the figures for ammonia nitrogen were: formalin, 54·5 p.p.m.; steam sterilized, 62·1 p.p.m.; and for unsterilized soil, 22·3 p.p.m. The nitrate figures on the above date were: formalin, 49 p.p.m.; steam sterilized, 61 p.p.m.; and for unsterilized soil, 72 p.p.m.

Samples of soil from the soil-conservation reserve on the Wither Hills, Blenheim, have been examined in the laboratory. The analytical results show that the soils are acid, with pH values lying between 5·2 and 5·8, and deficient in available phosphoric acid. It would appear that attention must be paid to both lime and phosphate treatment for the successful growth of subterranean clover.

*General.*—The advice of the Cawthron Institute has been sought by the Rehabilitation and State Advances Departments concerning the suitability of several properties for returned servicemen. Inspection of these properties was undertaken and reports prepared for submission to the appropriate authority. The Nelson Catchment Board has likewise sought the help of the Institute in soil-erosion problems and land classification.

## Tomato Investigations

During the past season work has been continued on the treatment with steam and soil disinfectants of both glasshouse and outside tomato soil. Further work on "cloud" has been carried out in our tomato-house, and the incidence of "hard core" in both glasshouse and outside conditions of culture has been studied.

(1) *Use of Steam and Formalin for the Treatment of Glasshouse Tomato Soil.*—Both steam and formalin treatments of the soil have been carried out and tomato plants tested both with and without fertilizer treatment. Typical results are as follows:—

| Treatment. | Yield per Plant. |
|---|---|
| | lb. oz. |
| Steamed each season | 8 2 |
| Unsterilized for two seasons | 4 15 |
| Formalin treatment (previously unsterilized for three seasons) | 6 5 |

Note.—Standard fertilizer and standard watering used on all the plots.

The results confirm the importance of steam sterilization in improving the yield of glasshouse tomatoes under Nelson conditions of culture. Distinct improvement in yield, but not so great as with steam treatment, followed the use of formalin at the rate of 1 pint of 40 per cent. formalin per square yard of soil. Further evidence was obtained of the deterioration in both growth and yield of tomatoes when the soil remains unsteamed for two successive seasons. Thus the yield on the unsteamed plot in the first year was 5 lb. 10 oz. per plant. In the second season the yield fell to 4 lb. 15 oz. per plant.

In previous years the effect of fertilizers in augmenting the yield of tomatoes on steam-sterilized soil has been comparatively small. Some evidence, however, was obtained last season that yields were falling when fertilizers were omitted from the steam-sterilized plots for two successive seasons. This year the plots without fertilizer showed distinct symptoms of nitrogen shortage and growth of plant fell below the corresponding plots with fertilizer. The yields of tomatoes were correspondingly affected, as the following figures show:—

| Treatment. | Yield per Plant. |
|---|---|
| | lb. oz. |
| Sterilized plus fertilizer | 7 9 |
| Sterilized (no fertilizer for two seasons) | 5 6 |

On the unsteamed and formalin-treated plots the use of fertilizer was accompanied by increased yield.

The drop in yield on the steamed plots without fertilizer suggests that the amount of available plant-food liberated by steam sterilization is insufficient in the second season to provide for optimum growth and yield of tomatoes.

(2) *Tests of Soil Disinfectants on Outside Tomato Soil.*—The use of steam and formalin has been continued on outside tomato soil. In addition, chloropicrin was used for the first time in these experiments.

In the early stages of plant growth following the use of steam or soil disinfectants, decided benefit to the growth of the plants was obtained with all treatments. Chloropicrin and steam treatment resulted in particularly vigorous growth, which was in striking contrast to the rather poor growth on the unsterilized plots. Unfortunately, very wet conditions prevailed throughout the season, and despite the application of sprays disease became very prevalent, making yield records unreliable. In this experiment the Potentate variety of tomatoes was used. In the previous season under much drier conditions this variety had given splendid results, but under wet conditions it showed greater susceptibility to disease than the Kondine variety.

(3) "*Hard Core.*"—During the past season records have been kept of the amount of "hard core" on individual plots with different fertilizer treatment or with different soil disinfectants. The wet season with a high degree of disease incidence was unfavourable to the experiment and little new information was secured.

Observations concerning the incidence of "hard core" were made in the glasshouse where tomatoes under different conditions of fertilizer and soil treatment were available. Some plots showed a considerable amount of "hard core," the worst plots for this disorder being the formalin-treated and the unsteamed plots both without fertilizer. "Cloud" on these two plots was very low.

(4) "*Cloud.*"—The Dreadnought variety was again tested under different conditions in the Institute glasshouse. Individual records were kept of some two hundred and sixty plants under different treatments, including steam sterilization, use of fertilizers, different rates of watering, and pruning. In addition, plants were grown in sand and fresh soil to secure information concerning the incidence of "cloud" apart from old tomato soils or soils that had been steam sterilized. Although the records are not yet fully assembled, it can be stated that further confirmation has been obtained concerning the association of "cloud" with heavy watering of plants and a great reduction of "cloud" when the normal watering programme is restricted.

The following results show the effect of different rates of watering on the incidence of "cloud" during the past season:—

| Rate of Watering. | "Cloud," per Cent. | Yield per Plant. |
|---|---|---|
| | | lb. oz. |
| Half standard .. .. .. | 4·1 | 7 14½ |
| Standard .. .. .. | 19·1 | 8 11 |
| Double standard .. .. | 32·5 | 8 7 |

## Fruit Research

*Magnesium Deficiency in Apples.*—Observations have been continued on the apple-trees at Tasman and Braeburn treated with various magnesium-containing compounds in the 1939–40 and 1940–41 seasons. At both centres Cox's Orange and Sturmer trees steadily improved in condition for several seasons, those trees treated in both years being the better. It has now become apparent that the effectiveness of the various compounds used (dolomite, magnesium carbonate, and magnesium sulphate) has not been the same, although the rate of application as magnesium element was identical. Dolomite, especially where applied either at 12 lb. per tree in one season or at 6 lb. per tree in each of two seasons, has consistently given more lasting benefit than magnesium carbonate and more especially than magnesium sulphate. During the last two seasons, although some defoliation occurred on Cox's Orange, the ailment has been under control to a degree sufficient to develop the crop satisfactorily. Untreated trees have been in very poor condition and stand in marked contrast to the neighbouring plots of treated trees.

In each season samples of leaf blades have been obtained from the various areas and on chemical analysis have shown increased magnesium contents for material from treated trees.

*Vitamin C in Apples.*—Work in 1944–45 included the monthly examination of fruit held under what approximated to orchard-storage conditions. The first analyses were made at the end of May and were continued until the end of September for most of the varieties. In most cases separate determinations were made on flesh and skin. Typical figures, expressed in milligrams of vitamin C per 100 g. of fresh material on the two dates mentioned, were, respectively: Sturmer, whole fruit 23 and 18, flesh 18 and 16; Granny Smith, whole fruit 8 and 4·5, flesh 5 and 3; Delicious, whole fruit 12 and 12, flesh 8 and 1·5. Statesman was outstanding for the vitamin C content of its skin, the early samplings giving about 90 mg. per 100 g. of fresh skin.

Besides the vitamin C content, the titratable acidity was estimated at each sampling. This fell rapidly at first and then more slowly in a manner similar to that shown by the changes in vitamin C content.

*Vitamin C in Fortified Jams.*—A number of jams, fortified with rose-hip powder or with pure ascorbic acid, were prepared by a local manufacturer and have been held for up to six months under ordinary laboratory conditions to see what changes might occur in the vitamin C content. Jams fortified with rose-hip powder and containing originally 40 mg. to 50 mg. vitamin C per 100 g. of jam lost on an average approximately 16 per cent. of their vitamin C content in three months, but lost very little more after a further three months' storage. When pure ascorbic acid was used to bring up the content to about 500 mg. per 100 g. of jam, the losses after three months averaged slightly less than 6 per cent.; data for the six-months period are not yet available.

*Die-back in Apples.*—During recent years apple-trees in certain orchards throughout the district, but more particularly on the Moutere Hills, have shown marked symptoms of "die-back," which eventually causes the death of several branches or even the whole tree.

In early stages of "die-back" one or two branches may fail in the early spring to develop blossoms and foliage in a normal manner. Later in the season a fair recovery of foliage may be found, but yields of fruit on affected branches are adversely affected. In succeeding years the effect on the tree is more serious and several branches may be killed.

The trouble is found in both good and poor orchards, although it is generally more drastic in its effect on poor thin soils. A preliminary survey of "die-back" in several orchards has been made, and it is hoped to continue both field and laboratory examinations during the 1945–46 season.

*Apple-stock Experiments at Annesbrook Orchard.*—The past season has shown again the superiority of Double Vigour stock (French Crab Seedling vegetatively propagated) over Northern Spy stock for the Statesman variety on the Annesbrook soil. This block was planted in 1931, yields being recorded for the first time in 1938. In the earlier years of bearing, trees on Northern Spy stock gave a slightly higher yield, but during the last three years the trees of the more vigorous stock have outstripped easily the trees on Northern Spy. In the 1943–44 season the yield of trees on the Double Vigour stock was approximately 1 bushel per tree greater than those on Northern Spy. The following table shows the yields of Statesman on the two stocks over the last four years:—

| Season. | Northern Spy, Pound per Tree. | Double Vigour, Pound per Tree. |
|---|---|---|
| 1941 .. .. .. .. | 101 | 116 |
| 1942 .. .. .. .. | 116 | 134 |
| 1943 .. .. .. .. | 126 | 148 |
| 1944 .. .. .. .. | 167 | 209 |

Yields were recorded for the first time from Cox's Orange and Jonathan blocks planted in 1934 and 1935. In these experiments a comparison is being made of Northern Spy stock and a locally produced vegetatively propagated seedling stock, and Northern Spy and three Malling stocks, Nos. 1, XIII, and XV.

In the case of both Cox's Orange and Jonathan, the more vigorous seedling stock is already giving a higher yield than Northern Spy by as much as ½ bushel per tree. In regard to the East Malling stocks, which were planted together with their control Northern Spy stock a year later, the yield from M I stock is a little higher on both varieties than Northern Spy, with M XIII and M XV stocks well behind.

*Survey of Raspberry Soils.*—Typical soils located in all the important centres of raspberry culture in the Nelson district were examined both in the field and in the laboratory. The best gardens were invariably associated with sandy loams of good depth and free drainage. Where drainage was impeded, gardens frequently showed signs of deterioration. Raspberries on heavier types of soil—*e.g.*, silt loams—were inferior to those on sandy loams. The best gardens had yields of 3 tons per acre, and many gardens, particularly in the Tadmor Valley, averaged over 2 tons per acre.

All the soils used for raspberries were high in available phosphate but were low to very low in available potash. Considerable variation in pH value of the soils was found. The average for twelve typical soils was 5·9, but values as low as 5·3 were found.

The chemical analyses suggest that potassic manures in the fertilizer mixture could be increased with advantage, and in some gardens light dressings of ground limestone at the rate of ½ ton per acre should be applied.

*Disease Survey of Raspberries.* At the request of the Nelson Raspberry Marketing Committee a survey of diseases affecting raspberries in the Tadmor Valley was carried out. One or two gardens, as the result of flooding and wet soil conditions, had suffered badly from root-rot fungi, particularly *Rosellinia* and the silver-leaf fungus. In other gardens only isolated plants were affected. Fructifications of the cane-wilt fungus were present and also, where soil conditions were wet, those of the fungus *Nectria*. With few exceptions the gardens were in a healthy state.

*Bulletin on Raspberry Culture.*—With a view to the extension of raspberry culture in the Nelson district, help was given to the Nelson Raspberry Marketing Committee in compiling a bulletin dealing with the culture of the crop in the Nelson district. The technical sections of the bulletin were written by officers of the Cawthron Institute.

## Cobalt Investigations

*Field-work.*—At Sherry River the experiment commenced last season, in which applications of cobalt sulphate at the rates of 4 oz. and 8 oz. per acre were made, has been continued with interesting results. A plot which had received 16 oz. cobalt sulphate per acre in August, 1940, but no cobalt since that date was also available. Little difference in the average live-weight of the sheep on the different plots occurred during the summer, but in the spring of 1944 marked differences in the appearance and health of animals of the various groups became manifest. Those animals on the control (no cobalt) area became poorer in condition, and later some of them died. It was noticeable, too, that the "finish" of those animals on the 8 oz. area and the area originally treated at 16 oz. per acre was superior to those on the control and 4 oz. area even where no marked differences in weight were shown. Starting with an average live-weight of about 53 lb. in 1943, the weights on 18th March, 1945, were as follows: control, 89 lb.; 4 oz. cobalt sulphate per acre, 105 lb.; 8 oz. cobalt sulphate per acre, 111 lb.; and the heavy application of 16 oz. in 1940, 126 lb. The animals of the last two groups were in fat condition. It is evident from these data that while both the 4 oz. and the 8 oz. applications have been beneficial, the latter has given the better result, and that both these rates of application have been sufficient to maintain sheep in health on this cobalt-deficient pasture for eighteen months.

The wool yields from the above groups are also of interest. The animals were shorn in December, 1944, when the following average weights of raw wool were obtained: control (no cobalt), 7·3 lb.; 4 oz. cobalt sulphate per acre, 7·5 lb.; 8 oz. cobalt sulphate per acre, 7·7 lb.; 16 oz. cobalt sulphate per acre in 1940, 9·5 lb.

Pasture samples have been obtained periodically from the above plots and have been analysed for cobalt content. The cobalt contents have been higher for material from the treated areas, correlating well with the live-weights of the animals.

*Laboratory Investigations.*—A number of limestones, corals, and shells of molluscs from serpentiferous locations has been examined for cobalt content at the request of Professor Benson, of Otago University. Quarry limestones were sampled at different depths. The analytical data indicated that considerable variations in cobalt content sometimes occurred at the different levels, more particularly if there were any change in the geological strata. Coral-reef limestones and recent molluscan shells were found to be low in cobalt.

Several soils derived from serpentine and two serpentines were also analysed for acid-soluble cobalt. High values, up to 385 p.p.m. of cobalt (Co), were found.

## Magnesium Investigations

(*a*) *Serpentine-superphosphate.*—Pot Experiments: Material from the pot trial with serpentine-superphosphate, mentioned in last year's report, has been analysed. No increase in magnesia content followed from the use of serpentine either as serpentine-superphosphate or in admixture with the soil before adding the superphosphate; on the other hand, all phosphate treatments increased the $P_2O_5$ content of the crop. Basic superphosphate and superphosphate plus lime gave the highest potash and nitrogen contents. Superphosphate plus lime doubled the lime content as compared with those of the other treatments (0·7 per cent. CaO).

In the 1944–45 season further pot trials have been established with a view to the elucidation of the special effect shown on the granite soil of Sherry River to applications of serpentine-superphosphate. Different phosphatic fertilizers used in conjunction with nitrogen and potash are being compared, using Western Wolths as the indicator crop. The results from this experiment are not yet available.

Preparation of Serpentine-superphosphate: Laboratory experiments on mixing a waste product from the preparation of asbestos in the Cobb Valley area with superphosphate in the dry or slightly moistened condition have been made without results being very promising for the use of this material in place of ground serpentine for making a magnesium-containing fertilizer. Although reaction took place, indicated by some reduction in the water-soluble phosphate and lime contents and some increase in the water-soluble magnesia content, the reaction did not proceed sufficiently far to reduce the soluble phosphate content to the standard figure set for serpentine-superphosphate.

(*b*) *Magnesium Deficiency in Apple-trees.*—Variations in the chemical composition of leaves at different distances along the new season's growth make it essential to sample leaf material judiciously. Magnesium has been found to be at a minimum in the lower leaves, particularly the fifth and sixth from the base, and there is a progressive increase to the tip leaves. Thus, with Cox's Orange, values in leaves from magnesium-deficient leaders range from 0·04 per cent. (as Mg) to 0·37 per cent., and with healthy leaders from 0·08 per cent. to 0·42 per cent.

There is a marked inverse correlation between magnesium and potassium contents of the dry matter of apple-leaves. The respective values for potassium (as K) in the examples cited above are 2·5 per cent. to 0·5 per cent., and approximately 1·3 per cent. to slightly less than 1·0 per cent.

In potassium-deficient leaders, however, the values are of quite a different order. Magnesium did not fall below 0·20 per cent., with an average of approximately 0·3 per cent., while potassium varied from below 0·1 per cent. to only 0·46 per cent.

These data strikingly emphasize the need for first obtaining precise information on mineral distribution in the various leaves before reliable sampling in deficiency studies can be achieved.

*Mineral Content of Phormium tenax.*—Samples of leaves from the flax-nutrition experiments at Sergeant's Hill, Westport, have been analysed for nitrogen and mineral contents. Six different treatments were represented—namely, superphosphate, superphosphate plus nitrogen, superphosphate plus potash, superphosphate plus nitrogen plus potash, nitrogen plus potash, and untreated. On this pakihi soil a high deficiency of phosphate occurs and growth is exceedingly poor both on the untreated plot and that manured solely with potash and nitrogen. In the leaves on these two plots only 0·14 per cent. and 0·12 per cent. $P_2O_5$ respectively were found. The other samples gave 0·20 per cent. to 0·32 per cent. $P_2O_5$. The use of phosphate was associated with an increase in both lime and magnesia contents. Potash and nitrogen contents were not directly correlated with the use of these fertilizers in the manurial treatment of the flax.

## RESEARCH WORK AT AGRICULTURAL COLLEGES

Grants were made by the Department during the year to Canterbury Agricultural College and Massey Agricultural College for a number of projects, which are reported on below.

### CANTERBURY AGRICULTURAL COLLEGE

#### Subterranean Clover Investigation

J. W. Calder

The sixth grazing season has been the most productive experienced in the course of the investigation. As a result of good autumn rainfall and a mild winter it was possible for the first time to winter the ewes and hoggets on herbage produced on the experimental area without the assistance of hay or other supplementary feed. Surplus growth in the spring was grazed by five hundred hoggets over a period of one month.

The carrying-capacity, expressed in terms of ewes per acre, is as follows:—

| | Ewes per Acre. | | | | | |
|---|---|---|---|---|---|---|
| | First Year. | Second Year. | Third Year. | Fourth Year. | Fifth Year. | Sixth Year. |
| A treatment: 1 cwt. super. alternating with 5 cwt. lime .. | 1·0 | 1·3 | 1·6 | 2·1 | 1·6 | 3·1 |
| B treatment: 2 cwt. super. annually .. .. .. | 1·3 | 1·2 | 1·2 | 1·4 | 1·7 | 2·3 |
| C treatment: 1 ton lime initial, 2 cwt. super. annually .. | 1·6 | 1·7 | 1·8 | 2·0 | 1·9 | 2·9 |
| D treatment: 1 ton lime initial, 2 cwt. super. and ½ cwt. potash annually | 1·6 | 2·1 | 2·3 | 2·3 | 1·8 | 3·2 |
| Average wool-clip in pounds: Ewes .. .. .. | 8·0 | 9·1 | 9·4 | 8·2 | 9·3 | 11·5 |

The production in any one year is influenced by climatic conditions, especially rainfall. The most productive season was that of 1944, when 9·5 in. of rain fell in February, March, and April. This assured an early and dense re-establishment of the clover. The winter was mild. Over 5 in. of rain were recorded for August, September, and October, and there was almost a complete absence of hot, dry winds in the spring. This combination of favourable climatic conditions resulted in record production. The annual variation in production emphasizes the need for care in the management of a light-land farm where subterranean clover is extensively used. The generally accepted policy of avoiding overstocking and providing adequate reserves of feed must be adopted. The decision to carry a predetermined number of ewes during the ensuing season can be made in the autumn. By this time re-establishment of the clover has occurred and a fair estimate of the coming season's production can be made.

*Effect of Fertilizer Treatment on Production.*—It will be observed that treatment A, which started off below treatments B, C, and D in the first year, surpassed treatment B in the second year, and treatment C in the sixth year in which it approaches treatment D.

It would appear—

(i) That the relatively light but recurring applications of lime and super. (equivalent to ½ cwt. super. and 2½ cwt. of lime annually) is more effective than heavy annual applications of super. (treatment B—2 cwt. annually):

(ii) That a heavy initial application of lime plus annual application of super. (treatment C) gives high production in the early years, but the effect of the lime diminishes, and by the sixth year production, while still higher than where no lime has been applied, is lower than where repeated light applications of lime and super. are applied (treatment A):

(iii) Potash (treatment D) has shown an advantage throughout, but here again the diminishing effect of the initial application of 1 ton of lime is apparent.

An interpretation of these results for practical guidance for the establishment and management of subterranean-clover pastures on light land would be—

(i) ½ ton lime and 1 cwt. super. in first year:
(ii) 1 cwt. super. and 5 cwt. lime in alternate years.

The cost of this treatment would average about 6s. per acre over a period of years, and this treatment is capable of increasing production of this light land from one half to three-quarters ewe per acre to over two ewes per acre. In addition, there would follow a considerable reduction in cultivation and resowing costs associated with the older methods of farming on this class of land.

## Entomological Investigations

L. Morrison

*Sheep-dipping Trials.*—(*a*) Lice Control: During the early part of 1944 the trials were concerned mainly with the effect of derris suspensions, as recommended for "ked" control, on body lice (*Bovicola ovis*). With the exception of one trial which gave negative results, all the other trials showed that ½ lb. derris (rotenone content not less than 5 per cent.) per 100 gallons of water gave complete control of lice. Since August, 1944, trials for lice control have been carried out with derris suspensions varying in strength from ½ lb. per 100 gallons water up to 2½ lb. per 100 gallons water. Sheep which have been dipped in derris suspension at strengths of 1 lb. and over per 100 gallons have remained free from lice. Examinations have been carried out at regular intervals and will be continued for at least twelve months.

A flock of forty sheep infested with body lice was dipped in a suspension of 2 lb. derris per 100 gallons water and isolated afterwards. This flock have so far failed to reveal any evidence of live lice, but the periodic examinations must be continued for several more months before final conclusions are reached. Attempts have been made to infest sheep with leg lice (*Linognathus pedalis*) in the reserve paddock, but so far without success. Arrangements have been made to carry out a field trial on Banks Peninsula, where a flock infested with leg lice is to be dipped in derris suspension. It is also intended to carry out a similar field trial on a flock infested with body lice as soon as opportunity arises.

(*b*) Sheep Ked (*Melophagus ovinus*), (continuation of trials): In the past it has been proved that the dipping of sheep in a suspension of derris (5 per cent. rotenone content) at the rate of ½ lb. per 100 gallons of water gave complete control of keds as long as the flocks remained isolated. Derris, however, may not protect sheep from reinfestation if they contact infested animals several months after dipping. In "run country" reinfestation is always likely to occur. Consequently, attempts have been made to obtain a material which can be mixed with derris to give the sheep prolonged protection from keds. Bentonite-sulphur in a wide range of concentrations has been tested and has been found to be satisfactory in reducing ked populations over a long period. The combination of bentonite-sulphur and derris destroys all keds just after dipping, and reinfestation of the dipped sheep by coming in contact with infested animals has been prevented over a short period. These trials must run for another eight months before final conclusions are drawn.

Paralleling the small-scale trials was a field trial in which four hundred and fifty ewe lambs were dipped in a bentonite-sulphur and derris suspension. These lambs were heavily infested with keds. They are now free from keds and will be run in contact with the main mob of ewes under open-range conditions, where reinfestation of dipped sheep always occurs. This trial will not be completed until next shearing-time—about December.

For the small-scale trials a further number of double-fenced pens have been erected, making a total of eleven pens. An area of about 5 acres is being used adjacent to the experimental pens for the maintenance of a reserve flock. Dipped sheep are then observed under two sets of conditions: (1) isolated after dipping; (2) running in contact with undipped sheep in the reserve flock.

## Wheat Insect Trials

Mr. L. Morrison

Trial plots were laid down on Wheat Research Institute land at Lincoln and on Mr. J. D. Hall's farm at Hororata. The plots were similar in both areas. Seven varieties—viz., Cross 7, Tuscan, Hunters, 78, 01, Tainui, Dreadnought, and Fife Tuscan—were included in the test. Each variety was sown in a plot comprising four rows and there were four replications of plots. The trials were designed to test the comparative resistance or susceptibility of the varieties to attack by stem weevil (*Hyperodes griseus*) and hessian fly (*Mayetiola destructor*) and to ascertain the degree of damage resulting from attack. Data were collected during the months of October, November, December, and January. The results were analysed statistically by Mrs. Boyce, of the Wheat Research Institute, and that assistance is gratefully acknowledged.

### A. *Stem Weevil*

(*a*) *Infestation.*—The results indicated that varieties which tiller freely and produce many stalks showed a higher percentage infestation than varieties which produce few stalks—*i.e.*, percentage infestation increased with increase in the number of stalks. This held with all the varieties tested except Dreadnought, which was much more susceptible than would be expected. Using percentage infestation as a basis of grouping, the varieties fall into three groups, thus:—

| Group 1: Low Infestation. | | Group 2: Medium Infestation. | | Group 3: High Infestation. | |
|---|---|---|---|---|---|
| Variety. | Percentage Damage. | Variety. | Percentage Damage. | Variety. | Percentage Damage. |
| Hunters .. .. | 9 | Cross 7 .. .. | 13 | Tuscan .. .. | 24 |
| | | Tainui .. .. | 14 | Fife Tuscan .. .. | 24 |
| | | 78, 01 .. .. | 17 | Dreadnought .. .. | 38 |

(*b*) *Tillers killed.*—There were highly significant differences between the number of tillers killed by the boring activities of the grub in different varieties, but the numbers killed were not correlated with the mean number of tillers per variety. Grouping the varieties on this basis was less definite although more or less similar to the grouping for infestation, although Tuscan and Fife Tuscan showed lower relative percentage loss, and the variety Fife Tuscan fell into a position which made it difficult to decide whether it should be included in Group 1 or Group 2. Grouping in this case was as follows :—

| Group 1. | | Group 2. | |
|---|---|---|---|
| Variety. | Percentage killed. | Variety. | Percentage killed. |
| Hunters .. .. .. | 2 | (Or) (Fife Tuscan) .. .. | (11) |
| Cross 7 .. .. .. | 7 | 78, 01 .. .. .. | 14 |
| Tainui .. .. .. | 12 | Tuscan .. .. | 11 |
| Fife Tuscan .. .. .. | 11 | Dreadnought .. .. | 18 |

(*c*) *Egg-laying.*—Samples examined during the month of October showed that there was no significant difference between varieties. Adult beetles lay their eggs equally readily on any variety and the average number of eggs per plant is approximately the same for all varieties.

## B. *Hessian Fly*

Hessian-fly infestation was so slight at Lincoln that no valid results from that area could be collected. On the other hand, Hessian infestation at Hororata was, as occurs every season, very heavy. The results given in the following tables are those from Hororata only.

Varieties grouped according to percentage *plants* infested :—

| Group 1. | | Group 2. | | Group 3. | |
|---|---|---|---|---|---|
| Variety. | Percentage infested. | Variety. | Percentage infested. | Variety. | Percentage Infested. |
| Tainui .. .. | 66 | 78, 01 .. .. | 74 | Hunters .. .. | 100 |
| | | Tuscan .. .. | 74 | | |
| | | Fife Tuscan .. .. | 86 | | |
| | | Dreadnought .. .. | 88 | | |
| | | Cross 7 .. .. | 90 | | |

Arranged in order of percentage *stalks* infested, the following would be the order of grouping :—

| Group 1. | | Group 2. | | Group 3. | |
|---|---|---|---|---|---|
| Variety. | Percentage infested. | Variety. | Percentage infested. | Variety. | Percentage infested. |
| Tainui .. .. | 19·2 | Fife Tuscan .. .. | 33·3 | Cross 7 .. .. | 47·6 |
| 78, 01 .. .. | 22·5 | Dreadnought .. .. | 37·8 | Hunters .. .. | 65·4 |
| Tuscan .. .. | 26·6 | | | | |

## C. *Stem Weevil and Hessian Fly*

Apart from reduction in yield due to mortality of tillers during the growing period of the crop, considerable losses occur just prior to harvesting by the breaking-over of stalks, previously damaged by either stem weevil or Hessian fly, during high winds in January and February. After stalks have been broken down it is not easy to determine which insect was responsible for the earlier damage which produced the liability to break readily. Breakage at Lincoln, however, was due very largely to stem weevil, for Hessian infestation was extremely light in that area, except in Hunters and Dreadnought and, to a lesser extent, Cross 7. Hessian infestation caused the greater part of the breakage at Hororata, for there it was much more severe than stem-weevil infestation.

The following table shows the varieties grouped according to the number of broken straws :—

| Group 1. | | Group 2. | | Group 3. | |
|---|---|---|---|---|---|
| Variety. | Number broken. | Variety. | Number broken. | Variety. | Number broken. |
| | | LINCOLN AREA | | | |
| Tainui .. .. | 43 | Hunters .. .. | 100 | Tuscan .. .. | 227 |
| 78, 01 .. .. | 59 | Fife Tuscan .. .. | 135 | | |
| Dreadnought .. .. | 74 | | | | |
| Cross 7 .. .. | 83 | | | | |
| | | HORORATA AREA | | | |
| Dreadnought .. .. | 73 | Tainui .. .. | 163 | | |
| Cross 7 .. .. | 99 | Hunters .. .. | 185 | | |
| Fife Tuscan .. .. | 113 | | | | |
| 78, 01 .. .. | 119 | | | | |
| Tuscan .. .. | 134 | | | | |

## Animal Production Research

J. W. McLean

*Progeny-testing.*—The major project carried out last season consisted of the progeny testing of "stud" and "flock" Southdown rams. Since the Southdown is a single-purpose breed, its virtue under commercial conditions depends on its ability to sire early-maturing, good-quality fat lambs out of crossbred ewes.

Five high-grade sires (stud) and five low-grade sires (flock) from the college flock were tested. The five high-grade sires were the stud rams selected for service in the stud flock last season. Besides being mated to Southdown ewes, each was mated also to twenty-five, three, and four shear Corriedale ewes. Each of the five low-grade sires was mated to twenty-five Corriedale ewes together with ten Southdown ewes cast from the ewe flock. Pure-bred progeny were therefore available for grading according to (*a*) breed-type characters and (*b*) visual conformation, &c., and sufficient crossbred progeny for grading according to (*a*) birth weight, (*b*) rate of growth, (*c*) carcass quality based on measurements at slaughter, and (*d*) general fat-lamb characters as assessed on the hoof. All pure-bred sheep have been graded for breed-type characters and visual conformation.

Owing to the abnormal seasonal conditions last spring and summer, the lambs in this trial, in common with most other lambs in Canterbury, were severely checked in December and few were ready for marketing as early-maturing high-quality fat lambs off their mothers. After weaning, they were transferred to fattening feed. In consequence, a great part of the value of the trial was lost. It is hoped, however, that some useful information will come from the statistical examination of the data which is in progress.

*Carcass-quality Studies.*—This work was continued last season by the measurement of growth and carcass quality of Southdown × Corriedale lambs associated with the progeny-test work above.

*Teeth Studies in Sheep.*—Last season this work was seriously curtailed owing to shortage of staff and pressure of other work. Observations were continued, however, on relatively small numbers of trial sheep at Ashley Dene and at the college with a view to establishing times of eruption and types of attrition.

*Inbred Strain of Romney Sheep.*—Work on the establishment of a pure inbred strain of Romney sheep for experimental purposes has been continued.

*Pig-breeding.*—Work on the establishment of a pure breeding strain of red pigs derived from Large White - Tamworth crosses has been maintained. Coat colour has been fixed, and carcass measurements on a small number of pigs of this strain have shown exceptional quality.

*Forage Crops for Lamb-fattening.*—This season a trial was carried out to compare the relative merits of the following crops and mixtures as lamb-fattening feeds: rape; sweet blue lupins; sweet yellow lupins; rape and sweet blue lupins; rape and rye-corn; rape and Italian rye-grass. Half-acre plots (two replications) of each crop were sown on medium land. Seasonal conditions were conducive to heavy and continuous growth in all treatments, particularly in the sweet yellow and sweet blue lupins.

Prior to the commencement of the feeding trial, yields per acre of green matter and dry matter were determined by cutting replicated quadrats on each plot.

Forward, store, three-quarter-bred wether lambs of even line were used as grazing animals. These were weighed, drenched with 20 g. of Phenothiazine, and distributed into twelve mobs by the usual method of restricted randomization. The number of sheep for each plot was estimated as the maximum number for which the available feed would prove ample during a minimum period of four weeks. Considerable difficulty was experienced in determining the starting-time of the feeding trial so that it would coincide as nearly as possible with the optimum stage for feeding of each crop. At the conclusion of the trial all lambs were weighed and drafted for marketing. Statistical examination of the results is in progress.

## Wool Metrology Laboratory

P. R. McMahon

*Wool Survey.*—Twenty-eight thousand fleeces were weighed and graded during the last shearing season, completing four years' observations at six locations. Two new locations were visited in the North Island and ten in the South Island, including one Merino flock in the Mackenzie County. The results from analyses so far carried out confirm conclusions stated in earlier reports, although good feed conditions during the last winter period appear to be showing up coarser fleeces to better advantage this year on some hill-country environments.

Full results of five years' survey investigation are being prepared for publication.

The contacts made in connection with expansion of survey investigations in the South Island have once more underlined the scope for increased sheep and wool extension services.

*Progeny Tests and Strain Trials.*—Progeny-test data have been collected and analysed for a total of eight stud flocks. In one of these, special methods are being tried in order to get further breeding data on untried rams with the minimum disruption of flock-management. Inquiries for progeny-test investigations have been received from a large Merino stud and a Corriedale stud.

First results will be collected in the coming season from a strain trial comparison of Romney rams with half-bred rams on half-bred ewes in North Canterbury hill country. Results will also be obtained from two separate strains of Romney rams in a flock run on Banks Peninsula. Other strain trials have been initiated. It is felt that this work should be extended, but that, since smaller differences will be found than are expected by breeders, much time and effort will be wasted unless the trials are under the direction of a suitable field officer.

*Intensive Investigations.*—Further data have been collected from the experiment with stud Romney and Corriedale sheep under accurately known nutritional environment. The following table of fleece weights records some of the more striking results:—

| Treatment Group. | Romney. | Corriedale. | Treatment. |
|---|---|---|---|
| High .. .. .. | 12·8 | 14·8 | 6 months' normal- and 6 months' *high*-plane feeding. |
| Low .. .. .. | 6·8 | 7·8 | 6 months' normal- and 6 months' *low*-plane feeding. |
| High .. .. .. | 15·6 | 18·0 | 12 months' high-plane feeding. |
| Low .. .. .. | 5·2 | 5·8 | 6 months' low-plane feeding and 6 months' maintenance. |
| High .. .. .. | 12·6 | 16·6 | 6 months' high-plane feeding and 6 months' maintenance. |
| Low .. .. .. | 6·6 | 8·4 | 12 months' maintenance. |

The wool of the Corriedale low-plane sheep, although fine, is very good to excellent in character; the Romney wool, on the other hand, is definitely lacking in character. The highest fleece weights obtained were 22 lb. greasy wool for twelve months' growth from a Corriedale ewe and 21 lb. for a Romney ewe. Both ewes reared lambs.

Hogget fleeces have been obtained from the progeny of the original high- and low-plane ewes shorn at fourteen months, the results being as follows:—

| —— | Romneys. | Corriedales. | —— |
|---|---|---|---|
| High .. .. | 19·7 | 19·3 | Optimum conditions. |
| Low .. .. | 7·0 | 9·1 | Corresponding to average hill country. |

The highest fleece weights recorded were: Romneys, 23·0 lb.; Corriedales, 21·8 lb.

Both the ewes and their offspring have been followed, at six-monthly intervals, with measurements of fat and suint content; fat and suint production per unit area; fibre length, diameter, density, and wool-production per unit area. The largest difference in clean-wool production between the high- and low-plane sheep amounted to 420 per cent. This was during the first six months of the experiment.

In an attempt to extend these more detailed studies of environmental effects on wool growth, some eight hundred samples from the Department of Agriculture's Kirwee experimental area have been graded and scoured. A total of 482 samples from copper- and cobalt-deficient areas have been examined.

Investigations so far carried out have given no support for the suggestion advanced last year that acidosis and/or ketosis, associated with pregnancy toxæmia, were directly responsible for interference with wool growth and the production of breaks in the staple.

*Wool Metrology.*—A large number of fineness measurements have been made in connection with wool survey and other projects. A few samples have been examined on behalf of stud breeders. The arrival of standard equipment for projection of fibres at a magnification of 500 diameters has speeded up this work.

Important anomalies are being found between measured fineness and count estimated by experts from the appearance of the sample in the grease.

A small number of samples have been scoured on behalf of wool-broking firms to determine yield of clean wool.

*Manufacturing Trial.*—Last year's attempt to procure raw material for a trial to determine the effect of medullation on the processing of 56's–60's wool failed to provide sufficient medullated wool, despite the examination of over one thousand fleeces. A further one thousand fleeces in about twenty lines were examined this season, and about 200 lb. of wool containing a small amount of medulla have been obtained. Most of this wool came from two lines of wool grown by hoggets not shorn as lambs.

It has become apparent that a great deal of wool which is substantially free from medulla is described by the trade as "hairy" because of damage by weathering influences which render the fibres harsh and brittle as well as interfering with their behaviour in the dye bath.

## MASSEY AGRICULTURAL COLLEGE

### Sheep Nutrition Experiments

E. A. Clarke

The contention has been advanced in many quarters that a large number of our stock troubles could be attributed to a simplicity rather than a complexity of diet and that perennial-rye-grass-dominant pastures tended to promote ill-thrift in stock. Also, it was contended that sheep in particular did not thrive on lush rye-grass–white-clover pastures, especially those pastures resulting from the heavy top-dressing of the newer strains of rye-grass and white clover. In view of these beliefs it was decided to carry out tests on productivity, thrift, and finish of breeding-ewes and lambs of—

(*a*) The following manurial treatments of a basic rye-grass–white-clover pasture—
- (i) 1 cwt. superphosphate per acre:
- (ii) 4 cwt. superphosphate per acre:
- (iii) 4 cwt. basic slag per acre:
- (iv) 4 cwt. superphosphate plus lime per acre:
- (v) 4 cwt. superphosphate plus lime plus potash per acre.

(*b*) The following pasture mixtures heavily top-dressed with lime and superphosphate—
- (i) Pedigree perennial rye-grass plus pedigree white clover (high H.C.N.):
- (ii) Pedigree perennial rye-grass plus low H.C.N. white clover:
- (iii) Pedigree perennial rye-grass plus mother seed white clover:
- (iv) Mother seed perennial rye-grass plus mother seed white clover:
- (v) Mother seed perennial rye-grass plus pedigree white clover.

These trials were commenced in March, 1940, and the grazing management was such as to keep the sward young and tender at all times. The results to date have been fully analysed, and so far as thrift is concerned—and this term covers a wide field—and so far as rate of growth and quality of fat lamb goes, no significant differences have been observed between any of the treatments, although they differ strikingly in carrying-capacity as expressed in ewe equivalents:—

Manurial Treatments—Carrying-capacity in Ewe Equivalents, per Acre (Four-year Averages)

| Manurial Treatment .. | (i) | (ii) | (iii) | (iv) | (v) |
|---|---|---|---|---|---|
| Carrying-capacity .. | 7·9 | 8·4 | 8·6 | 9·1 | 9·3 |

The differences are all significant except between treatments (ii) and (iii) and treatments (iv) and (v). The effect of lime on this class of land is very evident in carrying-capacity and vigour of herbage.

These trials were restocked with two-tooth ewes in March, 1944, and we are now commencing a second four-year period, and the effects of continued high levels of top-dressing with artificial fertilizers will be studied. The replicated plots have been comprehensively sampled at successive 2 in. depths in order to study changes in soil composition under the different manurial treatments:—

Pasture Strains—Carrying-capacity in Ewe Equivalents, per Acre (Four-year Averages)

| Pastures .. .. .. | (i) | (ii) | (iii) | (iv) | (v) |
|---|---|---|---|---|---|
| Carrying-capacity .. | 9·6 | 8·5 | 8·9 | 8·8 | 9·4 |

The differences are all significant except between pastures (i) and (v) and pastures (iii) and (iv). A marked increase in carrying-capacity results from the inclusion of pedigree white clover.

This trial, having demonstrated clearly that the new selections of rye-grass and white clover do not promote ill-thrift in sheep, has been discontinued and the area has been laid down to test carrying-capacity, problems of management, and effects on thrift of short-rotation rye-grass as compared with perennial rye-grass under set stocking and rotational grazing. The area has been sown and will be stocked to capacity with ewes this year.

Trials with an iodine drench have clearly demonstrated that the occurrence of goitre in lambs on this area can be entirely eliminated.

## Progeny-testing for Improved Mutton and Wool Production

R. Waters

During the year ended 31st March, 1945, 435 ewe hoggets, the off-spring of twenty-four sires, have been progeny-tested for body and wool characters of commercial significance.

Eleven sires and a considerable proportion of their ewe hoggets have been culled from the Voss flock on these tests. (It may be mentioned in passing that several official Romney judges are agreed that the process of culling and selection on progeny-testing has demonstrated its worth in both the Voss and the Buchanan flocks.) We are more especially concerned with the detection of sires of special merit for subsequent test by close breeding. The progeny of three such sires were found to warrant further study. The progeny of all three sires were shown as above average in body conformation; that of the first as above average in both wool weight and character; that of the second also as above in wool weight; and that of the third also as above in wool character.

Limited close breeding has been commenced with the first sire. The second and third are half-brothers (the second died recently). An undesirable character having appeared in certain half-uncles of these two sires, a number of their sons are now being mated for progeny-testing and with a view to determining their suitability for future line breeding.

Thirteen sires have now been tested twice—a few more than twice—and an examination of records is proceeding in respect to the repeatability of their performances. In many of the thirteen the repeatability appears good, but there are a few notable exceptions requiring further study.

Measurement methods in respect to hairiness have now been completed. On this subject four papers have been written and now await publication. A fifth paper, on mutton conformation, is now in the course of publication.

It may be added that our recording system used in progeny-testing is being adopted still more widely by breeders since its recognition in the last two flock-books of the Romney Breeders' Association. The system has been taken up by Lincoln and has more recently been availed of at Ruakura.

## Agricultural Biochemistry (Animal Nutrition)

C. R. Barnicoat

*Milk-supply of the Romney Ewe in relation to Growth of the Lamb: the Effect of Age.*—For the 1944–45 experiment two groups, each of about forty, of line-bred Romney ewes were kept under similar conditions and allowed ample grazing.

The milk-yield of each ewe and the rate of growth of its lamb were measured at seven- to ten-day intervals and analyses were also frequently made of milks from certain selected animals.

As noted in previous years, there is a good correlation between the milk-yield of the ewe and the growth rate of its lamb. The yields of the six-year-olds proved to be greater, on the whole, and the milk richer than those of the younger animals.

*Deterioration of Teeth of Romney Breeding-ewes.*—A survey of the problem in several sheep-breeding districts failed to indicate any single factor responsible for either good—or bad—wearing teeth. It was therefore felt that a practical experiment, whereby ewes could be individually followed on various types of country, was necessary. Accordingly, about one thousand two-tooth ewes from the Massey College farms and from over a dozen farms in the Taihape area have been individually tagged, and it is intended that their teeth be examined at yearly or more frequent intervals.

Chemical and histological work on teeth from various areas is also under way.

## Research on Sheep Parasitology

J. H. Tetley

During the year ended 31st March, 1945, investigations in the field of epidemology of roundworm infection were continued. Experiments on the build-up of worm infection under field conditions were brought to a close. In this work intrinsic facts relating to the epidemic course of infection were obtained as well as facts of technical use in following the process of flock infection. Investigations of this type present difficulties in management of sheep as well as in disentangling the significance of the various factors of environment.

An analysis of the role of various factors of environment has been initiated. This work follows logically on experiments conducted under field conditions during 1944 and in previous years. Steps have been made to determine the influence of age in the process of acquisition of infection, to distinguish its significance from that of resistance acquired as the result of previous infection, and to assess the influence of seasonal differences in exposure to infection. *Haemonchus*, the large or twisted wireworm of sheep, has been chosen as the experimental species. This species is responsible probably for greater mortality among sheep in this country than any other parasite. Sheep for experimental purposes have been kept free of infection from birth by hand feeding.

## Drainage Research Work

A. W. Hudson

*Drainage Season 1944.*—An unusual feature of the winter and early spring of 1944 was the absence, until the 10th September, of drain outflows. The dry summer of 1943–44 conferred on the soil large absorptive capacity for water. Despite good rains in March and April, the ability of the soil to absorb all the rain which penetrated it was not exceeded, and the low winter rainfall of 8·2 in. from May to August inclusive did not create excessively wet conditions. Drains discharged freely on the 10th September and twice between that date and the 31st October.

A further unusual feature was the incidence of heavy discharges from drains on the 18th December and for several days in the first week in January following an unusually wet period. Over 7 in. of rain were recorded for December.

*Maintenance of Work and Recording.*—Records of drain outflows by using meters were obtained up to the end of November, after which the meters were removed as no further outflows were expected.

The experiments from which outflows were recorded were as follows: (1) a comparison of five different types of backfill material over tile drains; (2) a comparison of fast pulling with slow pulling of the mole plough; (3) uphill versus downhill pulling of moles; (4) a comparison of three different depths of pulling moles; (5) an experiment comparing the effect of a thick blade with that of a thin blade on the life of mole drains; (6) a comparison of two different types of plug.

*New Experiment.*—A comprehensive experiment to determine the relative merits of three methods of joining minor to major moles was instituted. The "McLeod," "spearing," and "cut-top" methods are being compared and junctions will be tested each year for a number of years. The real object of this trial is to determine whether the less laborious, and therefore cheaper, methods than the McLeod are satisfactory in use.

*Tile-trench and Open-ditch-digging Machinery.*—The necessity for land reclamation in England during the war has stimulated effort to cheapen drainage, and several new trench-digging machines have appeared on the market. The Scientific Liaison Officer in London has forwarded useful information about some of these machines, and steps are being taken to encourage their introduction by commercial concerns to this country.

## Research on N-type Sheep

F. W. Dry

Experimental breeding and other research has been continued on sheep with grossly kempy birthcoats (N-type) and very hairy fleeces. In 1944 some two hundred ewes were run at the college, and the same number are being kept in 1945 and, in addition, about a hundred and fifty at the Ruakura Animal Research Station. This birthcoat is known to be inherited in no less than three different ways. The knowledge being gained of what is here a defect has bearing, both direct and indirect, upon the production of different kinds of fleeces.

The work is also helping to bring to light new ideas about live-stock breeding in general. Recent work elsewhere on small animals and on plants has shown that selection may produce unexpectedly large results, in that hereditary factors may multiply one another's effects, and that certain hereditary changes are sometimes comparatively frequent. These ideas hold out the hope of faster or bigger results from planned breeding than used to be expected. The present experimental work with a farm animal—the sheep—is aimed in this direction.

Now that pure-breeding sheep with grossly kempy birthcoats are available, Miss Ross has been able to study the development of this extreme type of fleece before birth, and has made a good beginning in learning how this kind of coat develops differently from other coats. This work fits in instructively with that of Carter in Sydney on the pre-natal development of the Merino. Things that happen early in life are apt to leave their influence throughout life, and this understanding of early development is a contribution of general value for wool-production.

A simple but important principle in live-stock breeding is the early recognition of characters. This idea has long been in mind in the research now continued under the auspices of the Department of Scientific and Industrial Research on the fibre types of the fleece. A good example is afforded by the contrast between lambs with very kempy birthcoats that grow much kemp later and those which grow little. From certain detailed knowledge of the fibres composing the birthcoat Miss Ross can largely foretell in young lambs the later kemp situation. This will be helpful in selection where sheep with coats like those of the present experimental sheep are kept because they are adapted to harsh climates.

# DOMINION LABORATORY

Director: Mr. R. L. Andrew

The Dominion Laboratory is a service laboratory for Government Departments and has again dealt with a very large number of samples covering a wide range of materials. On various occasions members of the staff have assisted with advice on chemical and industrial problems. The policy of the Laboratory is to give assistance to industry in cases where the problem is one of general interest and of national importance.

A large amount of work has been done for the Armed Forces and war industries, but as far as possible the normal peacetime activities have been maintained.

The number of samples received at the Dominion Laboratory and branches during the year ended 31st December, 1944, were: Wellington, 10,725; Auckland, 8,334; Christchurch, 8,457; Dunedin, 2,660: total, 30,176, being an increase of 1949 samples over the preceding year.

## Customs Department

A variety of samples was examined for Tariff classification. The largest proportion of the work was in connection with illicit liquor. A sample of New Zealand-produced wood-naphtha for methylating alcohol was analysed and found to comply with the specification. Numerous tobacco samples were examined for moisture content.

## Health Department

*Milk.*—The numbers of milk samples examined were: Auckland, 6,744; Christchurch, 6,053; Dunedin, 2,105; Wellington, 4,133: total, 19,035.

The report of the Milk Commission which was published during 1944 served to maintain public interest in milk-supplies. Some of the city and town supplies were very unsatisfactory. Watering of milk is still a fairly common practice, and poor herds still continue to produce poor-quality milk. It will be difficult to remedy this position until more labour becomes available to the milk industry and to the inspecting authorities.

In spite of population increases, inspection staffs were below pre-war strength. School milk-supplies were regularly tested. Pasteurization of school milk was in most cases satisfactory.

*Water.*—A total of 930 samples of water was examined, mainly for the Department of Health.

*Sewage.*—Sewage and sewage effluent samples were examined. Many of these were for the control of camp sanitation. Some were effluents from linen-flax factories.

*Miscellaneous Food and Drug Samples.*—A very great variety of samples were examined. A small proportion only can be mentioned, namely, "Agrosan" aluminium saucepans, "Ankoria" baby food, ascorbic-acid tablets, bacon, "Brandinip," bread, butter, carbonated beverages, cat influenza remedy, cutting-oils, "Cyanogas," "Elasto" pills, field rations, fish-liver oils, fly-sprays, grape-juice, ice-cream, iodized salt, marking-ink, minced meat, "Partrite," rat poisons, "Rattler" rat-exterminator, "Renco" flexible tubing, roof water, rose-hip syrup, "Samson" iodine body-belt, sausage-meat, urine for T.N.T.

Of the bacon samples, at least fifty-four contained added boric acid.

Nine samples of white bread contained more than 45 per cent. of water in the crumb. Wholemeal breads contained from 46 per cent. to 48 per cent. of water in the crumb.

A large proportion of the ice-cream samples contained more than the permitted amount of milk-fat. A smaller proportion were slightly deficient in milk-fat.

Iodized salt in general contained the right amount of iodide. A few samples contained rather less than the minimum required and a smaller number contained more than the maximum allowed.

Three samples of sausage contained added synthetic colouring substances in contravention of the regulations. A sample of sausage contained 3·5 per cent. of sodium nitrite added by mistake instead of salt. This resulted in very severe poisoning. Steps are being taken to ensure that such a dangerous substance as sodium nitrite is adequately labelled to indicate the danger. Few of the samples of sausages examined contained the required amount of meat.

Meat products of various kinds contained excessive amounts of sulphite preservatives.

A large proportion of the rat poisons examined were either harmless to rats or so unattractive as to be ineffective.

It was found as the result of extensive investigations that water collected from new roofs constructed with asbestos roofing-materials was distinctly alkaline (pH 8·3 to 9·6). In one case where the roof had been in place only two days the pH was 10·5. The total solid matter in these waters ranged from 4·6 to 11·9 parts per million. Waters from older asbestos roofs had a pH ranging from 7·0 to 8·6. This indicates that the alkalinity decreases with age, but may still be appreciable after about two years. The conclusion was reached that the amount of lime dissolved from such roofs would not have any appreciable effect in water used for any ordinary purpose, including meat-pickling.

## Justice (Police) Department

*Wellington.*—Seven samples of blood and urine were examined for alcohol. In one fatal case it was estimated that the blood at its peak had contained 500 mg. alcohol per 100 g.

Ten exhibits were examined for poisoning. Four cases gave negative results, and others yielded toxic amounts of arsenic (one), veronal (two), sodium amytal (one), oil of wintergreen (one), and carbon monoxide (one).

The exhibits examined in connection with a fatal motor accident included glass fragments for identification and dust adhering to the car. The dust was identified as having come from a particular locality by the presence of spherical particles of molten slag from the fly-ash of an adjacent power-station smoke-stack.

*Auckland.*—Numerous samples of wine, beer, and spirits were analysed, mainly in connection with illicit sales of alcoholic liquors.

In a shooting case it was found possible to calculate the approximate distance from which the shot was fired by the distribution of powder grains.

In one case of burglary, chisel-marks on wood were found to correspond with a particular chisel and paint markings on the latter agreed with the three-coat paint system on the wood.

A fatal case of poisoning was found to be due to accidental swallowing of tetrachlorethane, which was separated from the organs for identification by Ragsky's process.

*Christchurch.*—In specimens forwarded for toxicological examination, arsenic, oil of wintergreen (two), bismuth, chloroform, and alcohol were detected.

Following the consumption of biscuits containing arsenic, two persons died and a considerable number of others were rendered seriously ill. An examination of the biscuits indicated that each contained $\frac{1}{3}$ oz. of arsenic, which had been added in mistake for ground rice.

Other exhibits included ether and ethyl chloride anæsthetics, blood and urine for alcohol content, and many liquor samples.

*Dunedin.*—Barbitone was present in considerable amount in exhibits from a fatal case of poisoning. Other exhibits were examined for traces of alcohol, mainly in connection with fatal traffic accidents. The stomachs of poisoned opossums contained hydrocyanic acid. The baits which had apparently been used to poison them contained alkali carbonates but no trace of cyanide. Articles of clothing were examined for seminal stains.

### Mines Department

The regular examination of large numbers of scheelite concentrates for tungsten and arsenic contents was continued throughout the year, and assays of ores for gold, silver, or other metals carried out as required. Mine airs and gases and stone dusts were analysed in connection with safety measures in coal-mines.

### Miscellaneous (from other Departments)

The variety of samples examined was too great to permit of mention of more than a few which were of special interest.

These included boiler scales, boiler feed waters, and investigation of boiler-tube failures; comparison of various rust-proofing treatments on steel; lead-cable corrosion; condenser electrolyte (analysis and preparation in bulk); mineral waters from Ngawha and Rotorua (with particular reference to boron and trace elements); fish-juice for salinity; pigments for roofing-tiles; synthetic-rubber washers; forsterite brick of local manufacture; filter-stones (for durability in service); beeswax (development of a New Zealand Standard Specification); and silica gel of local manufacture for comparison with the imported article.

### Building Research

Ever since the building of houses on a large scale was undertaken by the Housing Construction Department the Laboratory has been called upon to carry out examinations of many classes of building-materials and is the recognized testing authority for paints, roofing-materials, building-bricks, and many other essential items. The main work carried out during the year comprised examination of concrete and clay roofing-tiles (including a survey to obtain data for preparation of a standard specification), testing of bricks, asbestos-cement products, enamelled sinks, copper supply tanks, cork insulating-board, paints, wood-preservatives, and wood-preservation investigations.

In anticipation of a very greatly expanded housing programme in the post-war years, it was decided early in 1944 to send abroad two officers from the Laboratory staff to make a thorough study of recent developments in building-materials in Great Britain, Canada, and the United States of America, with particular reference to plastics, utilization of wood products, wood-preservation, fire-proofing of wood, painting procedures, cement, and ceramics.

After over a year abroad studying such problems, the two officers have now returned and the experience gained by them overseas will be invaluable to the Laboratory in its efforts to build up a Building Materials Research Section capable of giving a much better service to authorities concerned with housing construction and maintenance than has been possible in the past.

### Ceramics

Under the supervision of a Ceramic and Related Materials Research Committee the examination of raw materials for the ceramic industry was continued during the year. This work was carried out in close co-operation with Geological Survey.

Included among raw materials investigated were fireclays and decomposed rhyolites from Mount Somers; ball-clays from Kakahu; red-burning brick clays from Te Kuiti, Thames, Levin, and Kamo; aluminous and pottery clays from Whangarei and other North Auckland districts; processed clay washed from tertiary grit at Ligar Bay, Takaka; fireclays from open-cut at Huntly and from Murchison; bentonite from Porangahau; serpentines for addition to superphosphate; chalk from Oxford; glass-sands from Mount Somers and Ross; flints from Kaikoura; feldspar from Charleston and elsewhere.

For the State Forest Service limestones were tested for suitability for the manufacture of caustic soda for papermaking and advice given on white clay for paper filling.

In view of the plans for increased activity in the construction of dams and other major works by the Public Works Department, it became necessary to carry out detailed examinations of Portland cements from the three cement companies. Cements and clinkers were tested not only for compliance with B.S. Specifications, but also for heat-evolution characteristics and alkali content. It is only recently that the importance of alkalies in cements has become realized, since it has been found by workers overseas that in some cases interaction between alkali and certain types of aggregate may take place, leading to serious deterioration of the concrete. Though no instances of such failure are known to have occurred in New Zealand, the position is being carefully watched and regular examinations of local brands of cement made. This work is being continued.

During the year members of the staff engaged in ceramic work again had the opportunity of inspecting clay deposits and visiting potteries and cement-works.

### Chemical Engineering Section

*Drying Plant.*—The work on plant for the dehydration of vegetables and apples has been continued. The Section has undertaken the technical supervision of the dehydration factories under the control of the Internal Marketing Division, and in this connection plant tests have been carried out and special equipment designed. Reports have been prepared on the apple-dehydration plant at Hastings and on an investigation of the McBean drying-tunnel.

A dryer for agricultural materials has been designed for the Agronomy Division, Lincoln.

Some preliminary work has been done on an investigation of the drying of New Zealand bentonite. This work, which it is intended to continue during the coming year, will involve a study of the conditions of treatment, including drying and grinding.

*Tobacco.*—A survey has been made of the conditions existing in a tobacco-kiln at the Tobacco Research Station, Riwaka. The results obtained are being used in the development of a design of kiln which it is hoped will provide for greater efficiency and uniformity in the treatment of tobacco during the curing and drying process.

*Miscellaneous.*—During the year boiler tests were carried out in collaboration with the Coal Survey Section. Special instruments are being designed and made up or are on order, so that the Section will be well equipped for further work of this nature. The utilization of fuel is of benefit to industry and of importance from a national viewpoint.

An investigation of special methods of humidity measurement has been completed in collaboration with the Radio Development Laboratory.

The testing of knock-rating of aviation fuels on the C.F.R. engine for the R.N.Z.A.F. has involved the examination of over six hundred samples during the year.

Apparatus and experimental equipment have been designed for other sections of the Laboratory and for other branches of the Department—*e.g.*, special apparatus for the testing of oils and aviation fuels, blanching and sulphuring equipment for dehydration investigations at the Plant Chemistry Laboratory, and apparatus for studying the curing of tobacco leaf for the Cawthron Institute.

As in the past, members of the Chemical Engineering staff have been required to give advice on industrial matters and on problems arising in other branches of the Department.

### Coal Survey

The work of surveying the coal resources of the Dominion was continued under the general direction of a Committee comprising the Director of the Dominion Laboratory (Chairman), the Assistant Director (Secretary), the Director of the Geological Survey, the Chief Inspector of Coal-mines, the Superintendent of State Mines, the geologist in charge of field-work, and the chemist in charge of laboratory investigations.

The Committee met on six occasions during the year.

Twenty-six Coal Survey reports and fifteen information circulars were issued.

The analyses of all general samples made for other Government Departments or in connection with tests are summarized in Coal Survey Report No. 147 (12th February, 1945), which covers fuels and allied materials such as activated charcoal, char, peat, gas from boreholes, Australian coal, samples from boiler tests and from steam plants, fly-ash, briquettes, mine dusts, &c.

Work on the analysis of coal ash has continued and valuable information has been obtained regarding the presence of minor elements such as boron and strontium.

Consideration is being given to a comprehensive scheme for correlating all data relating to individual mines throughout New Zealand. The scheme involves fixing coalfield boundaries, establishing the location and record of each mine, locating and numbering boreholes, recording bore logs, and tabulating all analytical data. This information will be of value to the Mines Department, the Geological Survey, and the Coal Survey Section of the Dominion Laboratory.

### Highways Section

Due, probably, to the improvement in the war situation, there has been increased activity in road construction and maintenance, which has been reflected in the greater number of samples and inquiries received by this section of the Dominion Laboratory. This is well shown by the fact that the total number of samples received during 1944 was greater than the total number received from the beginning of 1942 to the end of 1943. Work requiring special investigation increased rapidly during 1944, but was practically non-existent during 1942 and 1943.

Many tars have been received from small gasworks throughout New Zealand for determination of their suitability as road materials to compensate for the lack of imported asphaltic materials. Some of these proved to be satisfactory and have since been used, after certain recommendations regarding alterations in manufacturing technique had been adopted. Other investigational work has been the development of mastic-asphalt fillings for the Karapiro Dam project, the investigation into suitable bituminous coatings for steel pipes used in the new Wellington water-supply, and utilization of existing stocks of asphaltic material for special purposes.

In spite of a lack of space, a good output of work has been kept up and there is every possibility that the work of this section will expand in future years as the volume of traffic and the demand for better roads increase. The design of roads can no longer be left to chance—strict scientific control is necessary at all times if road surfaces are to be expected to stand up to the greater loads and speeds of post-war traffic.

### Metallurgical Section

*Analytical.*—A wide variety of metals and alloys were analysed to determine their nature or their compliance with specifications. In this work considerable use was made of spectrographic methods both as a means of determining the metals present and of measuring the amounts, particularly of the minor constituents. Alloys examined included irons, steels, brasses, bronzes, nickel silvers, beryllium coppers, nickel-chrome alloys, silver-palladium contact metal, zinc-base alloys, type metals and other lead, tin and antimony alloys, aluminium and magnesium alloys.

*Investigational.*—A number of metallurgical problems were investigated—*e.g.*, difficulties being experienced by a firm manufacturing springs for a Government contract from silicon-manganese steel

were traced to serious defects in the steel as supplied from overseas. The steel was extensively decarburized on the surface and considerable graphitization of the carbon had taken place, rendering the material useless for spring-manufacture.

Two cases of serious porosity in iron castings were found to be due to faulty cupola practice in the foundries.

Unsatisfactory physical properties in manganese bronze were associated with the presence of traces of antimony introduced into the alloy from fired cartridge-cases used as a source of brass.

Machining difficulties with zinc base alloys were attributed to the presence of small amounts of iron which, although normally innocuous, in this case caused serious wear on the fine tools being used.

Porosity of the tin coating on tinplate for use in canning was measured and the corrosion resistance of terneplate as a substitute for tinplate for non-food containers investigated.

*Corrosion.*—Advice was given on the suitability of metals and alloys for use under specific corrosive conditions, and the cause of many failures examined.

Severe corrosion of gun-metal parts in a valve on a sewage digestion-tank was found to be due to traces of ammonia in the sewage gas.

Corrosion of gun parts and ammunition on storage was traced to chlorides introduced into canvas bags and bandolier cloth during the dyeing of the material.

Attack on a copper anemometer float was caused by contamination of the distilled water by sulphuric acid from acid jars used for transporting the water.

Deterioration of tinned cooking-utensils in Army stores was due to a residue of flux left on in the manufacturing process.

Nitric acid generated by electrical discharge was considered responsible for attack on brass parts of an electrical installation.

Corrosion of plumbing fittings led to a survey being made of the effect of artesian waters used for domestic purposes in the Hutt Valley. It was found that throughout the valley trouble was being experienced with corrosion of a variety of metals. Steel, zinc, lead, and certain copper alloys were most seriously affected, but more-resistant materials such as high-copper brass, nickel silver, and pure copper were also suffering attack. The cause of the aggressiveness of the water, which was very soft, was found to be free carbon dioxide, which varied in the supplies examined from 15 to 50 parts per million. Examination of concrete-lined pipes showed that leaching of the lime from the cement was causing deterioration of the linings. Lime treatment of the water was recommended for the correction of both troubles.

### Organic Section

The analysis of locally grown medicinal plants, mentioned in last year's annual report, was continued this year, with the same promising results. Further Fijian plants were examined for active principles.

The essential oils from some locally grown plants, notably caraway, peppermint, lavender, and chenopodium, were examined and found to be of very good quality.

The vitamin $B_1$, $B_2$, and C contents of various foodstuffs and beers were determined.

A formula for shark-repellent dyestuff tablets was evolved, and some work on D.D.T., the new insecticide, was also undertaken.

Several patent medicines were examined for the Health Department in connection with the Medical Advertisements Act.

A considerable amount of investigational work was undertaken for the Ministry of Supply, mainly in connection with complaints about imported commodities. Most of the complaints were found to be groundless.

### Mineralogical Section

Complete analyses of a number of type rocks of the Dominion have been done, chiefly for officers of the Geological Survey, and samples of very pure minerals completely analysed, including some very small samples of rare-earth minerals separated from sands.

Analyses of cement and cement clinkers were also carried out, special attention being given to the alkali contents of the cements.

The composition of an enterolith was also determined and the vanadium content of fuel-oil ash.

### Petroleum Section

The bulk of the work during the past year has been performed on behalf of the R.N.Z.A.F. A considerable number of analyses, however, have been made for the other Armed Forces.

Concurrently with the above activity promoted by special war conditions, the normal function of the Section has been maintained, and a substantial amount of testing has been performed for Government Departments, of which the Public Works, Post and Telegraph, Internal Affairs, Police, and Marine are examples.

The examination of aviation fuels has accounted for most of the routine work, though lubricating-oils, anti-corrosion compounds, transformer oils, hydraulic fluids, and ethylene glycol engine coolants have also been regularly examined to specification. A few greases have also been examined.

Investigational work has arisen from arson cases, suspected theft of aviation fuel, adulteration of motor-spirit with kerosene, engine corrosion problems, and correlation of test methods, including referee examinations.

In respect of the latter, a considerable amount of work has been done in confirming the accuracy under routine conditions of the A.S.T.M. method for determining tetra-ethyl lead in aviation fuels. The steam emulsion test in the evaluation of turbine oils has also received attention, and useful data have been accumulated on the examination of used crank-case and turbine oils.

The work has been complicated by the rapid changing of wartime specifications. This has necessitated not only constant vigilance, but also the provision at short notice of a variety of specialized apparatus. Some items have required improvization, but in most cases permanent equipment has been designed by the Chemical Engineering Section, and much of this is already in operation.

### Paint Section

With the improvement in the war situation, work carried out for the Armed Forces has decreased considerably and has been confined mainly to examinations for quality of miscellaneous Army, Navy, and Air Force and munition-making materials.

The number of samples of paint submitted by Housing and other Departments has increased very considerably. Special examinations have included comparison of New Zealand linseed-oil with imported oil for "break"; cement paints; fire-retardant paints; proprietary brands of enamels (general survey); traffic paints, distempers, and casein paints.

At the request of Housing, painting tests were made to determine on a variety of surfaces the relative covering powers of a range of paints prepared to Government specification.

Members of the staff acted on the Paints and Coatings Committee of the Standards Institute and on inter-departmental committees for paint investigation. Problems which were studied on behalf of the committees included durability of ordinary house paints on timber impregnated with wood-preservatives; primers for asbestos-cement and totara; development of casein paints; behaviour on exposure of exterior house paints; and mould on paints.

A weatherometer for the accelerated testing of durability of paints, bitumen, and textiles is now in service. A number of laboratory paint-mills and some mixing equipment has arrived and will shortly be put into use.

As the State housing programme expands with the close of the war, it is anticipated that the work on paint problems and analyses of paint for quality and adulteration will increase very considerably. The new equipment will be of material assistance in this work.

### Spectrochemical Section

Much of the work of this Section consists of the examination of metals, largely for compliance with specification, but also including qualitative examination of steels, aluminium alloys, &c. A considerable amount of work has been done on cooking-utensils cast from aluminium scrap. Saucepans were tested with 0·5 per cent. citric acid, as specified for enamelware. The ignited extract was examined spectrographically. If the metal contained over 0·03 per cent. of lead, undesirable amounts of lead were found, from 0·5 to 3 parts per million on the extracting solution. Antimony and cadmium were also occasionally found. Saucepans made from virgin metal of good quality were quite satisfactory. The citric-acid extract of a steel pot tinned with tin of poor quality also contained both lead and arsenic.

There was an increase in the amount of work done on biological samples. Cauliflowers were examined for the cause of whip-tail disease, as well as apples, and the leaves of apple and peach trees.

In connection with the determination of trace elements in the ash of a sample of milk-sugar sold as a "patent" medicine, a method was devised for the spectrochemical estimation of traces of fluorine.

The only forensic work was an examination of gold bullion. A point of interest was that indium could be detected in Waihi gold.

A method was worked out for the spectrochemical determination of strontium directly on rock samples instead of, as previously, on the calcium oxide separated from the samples.

### Physical Chemistry Section

On account of the difficulty of obtaining industrial pH meters from overseas, the Section co-operated with the Radio Development Laboratory in the design of an instrument required for brewing and wool industries. The electric eye is used as indicator in a circuit.

Work was done in conjunction with the Soil Branch of the Chemical Laboratory of the Department of Agriculture on the development of a conductivity method for determining the reactivity of ground limestones. The determination of resistance proved to be a simple and rapid method of indicating the content of salt in cloth for a military purpose, in which its presence caused corrosion.

A number of Weston cadmium cells were made for the Radio Development Laboratory.

Analyses were made of a number of electroplating solutions, and the thicknesses of various types of coating determined. The blackening of cadmium plating was ascribed to storage with traces of plating solution on the metal. Advice was also given on the surface coloration of metals, and on photo-engraving.

### Photographic Section

A technician has been appointed to carry out the photographic work required for the Laboratory, the Head Office, and some of the branches of the Department. A fair amount of the usual equipment as well as some photomicrographic apparatus is available, but recommendations have been made for a considerable expansion of equipment to provide for all types of work. A large amount of copying of documents, drawings, records, and charts was carried out during the year, as well as the making of prints from micro-films. Some photography was required in connection with laboratory tests, such as the weathering and wear of paints and the corrosion of metals. Photomicrography was undertaken in connection with investigations on metals and minerals.

### Spray Materials

Spray work for the Plant Diseases Division dropped to a minimum. A few samples of New Zealand grown pyrethrum flowers and of derris dust were tested. The remainder of the work consisted of the testing of fresh importations of spray materials.

### Gas Inspection

The gas-supplies of the four main centres and most of the other principal towns of the Dominion were regularly examined for calorific value, for pressure, and for freedom from sulphuretted hydrogen.

It has again been found that difficulties were very generally experienced owing to shortage of coal and labour. This has resulted in many instances in failure to maintain the usual standards and even in complete failure of supplies of gas for short periods.

The systematic testing of the accuracy of all gas-meters passed for service was carried out as usual,

### Library

The volume of work in the Library has led to the appointment of two librarians over the last two years. The change-over of classification of books to the universal decimal system has now been completely effected, and is being found valuable from the point of view of locating material on a desired subject. As the number of publications is rapidly increasing, space problems will soon become acute. The Library now contains close on three thousand books, exclusive of serial publications. Recent German books are becoming available through a lithoprinted reproduction of the original text carried out in the United States. Outstanding among such publications received by this Library is Beilstein's authoritative "Handbuch der organischen Chemie," in forty-nine volumes, with further volumes to be added as issued. Nine new periodicals are being subscribed to, on such subjects as food, glass, metals, paint, and chemical industries.

### Advisory and Consulting

As in the past, the Director and other senior members of the staff have been consulted frequently on scientific and industrial matters. They have continued to represent the Laboratory on many inter-departmental and other technical committees, including those of the New Zealand Standards Institute.

Members of the staff have again taken a very active part in the management of various scientific societies.

With a view to giving the maximum of assistance to industry, it has been the policy to encourage the staff to become familiar with manufacturing processes and difficulties by visits to works throughout the country.

## DOMINION OBSERVATORY

Acting-Director: Mr. R. C. Hayes

### Time Service

*Control of Clocks.*—The method of controlling the standard clocks has been the same as in previous years—*i.e.*, daily checking by radio time signals from Greenwich and Washington. Occasional local transit observations are also made. Improvements to the wireless receiving-apparatus made towards the end of 1943 have enabled more frequent check radio signals to be received.

*Time Signals sent out.*—The time-service arrangements have remained the same. The errors of the ZLW radio signals did not exceed 0·25 second on any day of the year 1944, the maximum error being lower than in any previous year. This high standard of accuracy is attributed mainly to the improvements in the wireless receiving-apparatus. There were two complete and two partial failures of the ZLW signals during the year, all due to causes outside the Observatory.

There is still an increasing demand for correct time by telephone. The number of calls received in 1944 was 1,732, as compared with 810 in 1943. Correct time is given by telephone daily to the Navy Department and the Tramways by special arrangement.

*Public Clocks.*—The Government Buildings clock was checked daily at 9 a.m. The maximum errors observed during the year was 48 seconds fast and 39 seconds slow.

The longest uninterrupted run of the synchronous electric clock was from 1st January to 2nd March (sixty-two days). The maximum errors observed during that period were 9 seconds fast and 22 seconds slow.

### Seismology

*Summary of Seismic Activity in New Zealand in 1944.*—During 1944 seismic activity showed a general decline as compared with previous years. No destructive shocks occurred, the maximum intensity reported felt being V+ on the Modified Mercalli Scale. There was some concentration of activity in the region south of Lake Taupo, but many of the shocks originated at considerable depth and were not perceptible.

The total number of earthquakes reported felt in 1944 was ninety-five. Of these, sixty-one were reported felt in some part of the North Island and forty in some part of the South Island. Six were felt in both Islands. These figures are based on reports from Post Office and lighthouse officials and from several private observers.

*Seismograph Stations.*—The Jaggar seismograph at Hastings, which had been out of action early in the year owing to repeated clock trouble, was in operation again by July. The seismographs at Auckland, Arapuni, Tuai, New Plymouth, Bunnythorpe, Wellington, Takaka, Kaimata, Christchurch, and Monowai were recording throughout the year.

The death occurred on 24th May of Mr. A. W. Burrell, of Stratford. Mr. Burrell was a noted astronomer, and for some time he operated a Jaggar seismograph for this Department.

*Records of Submarine Mines.*—With the co-operation of the Navy Department, useful records were obtained on the seismographs of a series of submarine mines fired in Wellington Harbour on 13th July. The records are being studied with a view to obtaining some information regarding local structure and wave velocities.

*Information regarding Earthquakes.*—From time to time information regarding the effects of earthquakes in various parts of the Dominion has been given to the War Damages Commission in connection with earthquake-insurance claims.

*Earthquake Studies abroad.*—Photographic copies of the Wellington and Auckland seismograms of several distant earthquakes were sent to persons and institutions abroad for detailed study of the earthquakes concerned.

### General

*Astronomy.*—Daily projection drawings of sunspots have been made with the 5-in. telescope of the Royal Society of New Zealand. Assistance in other astronomical matters has been given to the Carter Observatory from time to time.

## DOMINION PHYSICAL LABORATORY

Director: Dr. E. R. Cooper

*Advisory Committee.*—Professor T. D. J. Leech (Chairman), Mr. G. W. Wyles (Vice-Chairman), Dr. E. Marsden, Mr. W. M. G. Colquhoun, Mr. R. C. Porter, Mr. R. Burn, Mr. J. Brooke, Dr. E. R. Cooper, Mr. F. J. A. Brogan (Secretary).

Five meetings of the Committee were held during the year.

(1) The present annual report covers the sixth year of the establishment of the Dominion Physical Laboratory. The Laboratory premises now occupy a total floor area of 30,000 square feet and are situated in an otherwise unbuilt area of 17 acres Crown property at Gracefield, Lower Hutt.

(2) The functions of the Dominion Physical Laboratory, both in the war and post-war periods, were discussed by the Committee during the year, and it was recommended that they should be as follows:—

> The post-war functions of the Dominion Physical Laboratory shall be such that its decision on physical matters of precision, quality, and performance are accepted as final. Its functions are more specifically stated as follows:—
>
> (*a*) General research and development of a physical and engineering nature:
>
> (*b*) Calibration and repair and general testing of civil, mechanical, and electrical equipment:
>
> (*c*) Work for the New Zealand Standards Institute and general physical testing of goods and commodities:
>
> (*d*) Custody and control of the legal physical standards of measurement.

(3) Although during the past year the Laboratory has been busily engaged on direct wartime projects—*e.g.*, instruments, tools, and gauges for the Munitions Department, instruments for Navy Department, certification of gauges for the Armed Services, luminous painting of radio meters and dials for the Radio Controller—yet a considerable proportion of the work accomplished has been performed for New Zealand industry (instrument design, development, construction, and repair, testing and investigational work), Government Departments, and other New Zealand public institutions—*e.g.*, hospitals. It is anticipated that the latter work will continue undiminished after the war.

A pleasing feature of this year's work has been the increasing number of requests for assistance made to the Laboratory by industry, from which it would appear that New Zealand industry is becoming increasingly aware of the scientific and workshop facilities available for dealing with problems of an engineering and physical nature, especially with regard to instrumentation and precision-tool making.

(4) The Laboratory has been concerned almost wholly with the application of scientific knowledge and not with its discovery. The shortage of trained research engineers and physicists has prevented any attention being given to long-range research problems. The Laboratory has been fully engaged with work which is more aptly described as "servicing" and which is of great variety and changing from day to day. This calls for ingenuity and team action, and the staff is to be congratulated on the spirit of co-operation shown throughout the year. The number of personnel has been maintained at a constant level of one hundred and fifty over the past two years. Overtime to the extent of not less than twelve hours per person per week has been worked among the male staff throughout the year.

(5) Further progress can be reported with regard to the matter of legal physical standards of measurement in New Zealand, in that general agreement has now been reached by interested Government Departments on the form of a recommendation for an amendment to the Scientific and Industrial Research Act, 1926, and consequential amendments to other relevant Acts to provide for the custody and maintenance of primary standards of measurement by the Department of Scientific and Industrial Research. Such primary standards would embrace length, mass, time, heat, light, electricity, magnetism, and other forms of energy, and it would be the function of the Dominion Physical Laboratory to compare with the New Zealand primary standards and certify the secondary standards of measurement required by Government Departments in administering their legislation, and also to compare and certify the secondary standards of measurement used in engineering, manufacture, commerce, and science. The importance of maintaining such standards in the country has been more fully realized and appreciated during these war years, since precision measurement enters so fully into the establishment and conduct of industry and science.

(6) During the year extra floor area has been provided for the electrical instruments workshop and for the physical testing of materials. The air-conditioning plant for the metrology laboratories and the tool-room has been completed.

(7) Briefly summarized, the work completed at the Laboratory during 1944–45 has dealt with approximately 700 separate requests in the physical and electrical laboratories; 600 in the instrument workshops; 300 in the design section and engineering laboratory; 1,040 in the tool-room; 17,000 gauges have been measured in the metrology laboratory; the number of gauges manufactured was 11,700 and the number of tools 9,700; 2,400 sight clinometers and over 3,000 glass spirit-levels for same were made; 12,700 meters were painted with radioactive fluorescent material.

### Physical Testing and Electrical Laboratories

These laboratories together dealt with approximately seven hundred separate requests during the year for testing and investigation. The laboratories have an undertaking with the Navy Department to repair and test instruments off ships entering the Port of Wellington, and this accounts for about 50 per cent. of the optical instruments detailed below. The main investigations and designs made were:—

(1) *Bouncing Pin Balance for measuring the High Octane Content of Aviation Fuel.*—The balance, consisting of a single lever with movable weight on a graduated scale, was made in the workshops according to a design supplied by the R.N.Z.A.F. It was checked and calibrated in the physics laboratory.

(2) *Rubber Durometer.*—This instrument was constructed for the Army Inspection Department. Its design was based on the requirements of that Department. The calibration and final check was done in the physics laboratory.

(3) *Fabric-testing.*—An investigation has been carried out, in addition to a large number of routine tests, on the optimum size of cotton duck specimens. Two main factors are involved under given R.H. conditions—the width of the specimen and the degree of crimp in the thread. It was conclusively shown that well-crimped threads gave higher results on wide test pieces. Thread with little crimp gave higher results on narrow specimens, as these were more easily set evenly in the testing grips. A 2-in.-wide specimen has been suggested.

A technique has been developed for the accelerated ageing of linen and cotton threads, giving appreciable deterioration in four weeks. It consists of submitting the threads to cycles of water immersion, drying, and ultra-violet light. The method is used for comparing various types of thread and cord.

(4) *Mould in State Houses.*—The early stages of this investigation were outlined in last year's report. An extensive programme has since been carried out involving continuous observations during the winter months of temperature, relative humidity, and rate of air movement in typical rooms in State houses, some of which were mould-infested and others free from the trouble. The collateral laboratory work necessary for the interpretation of these observations is now approaching completion, when it is anticipated that the physical conditions determining the incidence of the mould will become clear. Methods of altering these conditions to eliminate the trouble should then be apparent.

(5) *Universal Humidity (20 per cent. to 100 per cent. R.H.) and Temperature (30–120° F.) Controlled Cabinet.*—The design and development of a humidity and temperature controlled cabinet for the control of relative humidities from 20 per cent. R.H. to 100 per cent. R.H. to within ±1 per cent. and of temperatures from 30–120° F. to within ½° F. is nearing completion. This project was initiated about two years ago for the investigation of the behaviour and probable useful life of materials and equipment destined for tropical conditions for the Armed Services. Initially most of the work was done with high atmospheric temperatures and humidities. Owing to the constant demand on the use of the cabinet, actual development was slow and rather spasmodic—the use of sprays, injected steam, and driers being later introduced. During the past six months it has been possible to improve the cabinet by the incorporation of refrigeration with modifications of the initial electrical input of heat, until now a valuable piece of equipment of very close control in temperatures and R.H. over most of its range has been produced. This is regarded only as an experimental model in which the method of close control can be developed. Several inquiries from other branches of the Department of Scientific and Industrial Research and Government Departments have been made for humidity controlled equipment, and it is expected that further requests for information will be forthcoming.

(6) *Turakina Tunnel (Telescope for examining Space between Tunnel Wall and Rock Country).*—A request from the Public Works Department through the Soil Survey Branch, Department of Scientific and Industrial Research, for the development and design of a telescope for inserting through holes let in the walls of the Turakina Tunnel for examining the space between the wall and the country behind was met by the optical section of the physics laboratory, in collaboration with the design section and workshops. As a result, two telescopes have been ordered, one completed and supplied, and the other nearing completion.

(7) *Equipment for measuring Radon Content of Breath Samples taken from Radioactive Paint Personnel.*—The establishment of a radioactive paint section of the Laboratory involved the necessity for providing a means of checking the extent of the ingestion of radioactive material by the personnel engaged in the painting. The quantity of radioactive material which may have serious, if not fatal, consequences on the human subject is so extremely minute that only very elaborate equipment and an exacting technique can cope with the problem. After some preliminary experiments, arrangements were made with the Travis Radiophysics Laboratory at Canterbury College to set up and operate a suitable plant to test air samples submitted from painting personnel and painting-rooms. Part of the plant was built and installed by the staff of the Dominion Physical Laboratory, and part by the Travis Laboratory, in close consultation, and the measurements since carried out there have removed any anxiety as to the extent of the risks undertaken by our painting staff.

(8) *Vibration of a Concrete Pier arising from nearby Detonation of Explosive under Water.*—During the year the Laboratory was asked to estimate the extent of movement or vibration set up in a concrete pier caused by the detonation of several tons of explosive situated some 300 yards distant, under water, from the pier. A strong-motion seismograph was devised and mounted within the pier and arranged to operate automatically during the series of detonations. The record obtained was afterwards analysed by the aid of an improvised shaking table, and from the results it was found possible to deduce with some precision the extent of movement experienced by the pier.

(9) *Physical Characteristics of Rock Foundation of the Maractai Dam.*—An investigation of considerable magnitude was initiated by the Hydro-electric Branch of the Public Works Department in connection with the location of a suitable site for the construction of a 200-ft.-high dam at Maractai on the upper reaches of the Waikato River. The site was examined by officers of the Laboratory in consultation with the design engineers of the Hydro-electric Branch. As a result, rock samples have been taken from shafts and drives, tunnelled into the banks of a proposed site, at 15 ft. intervals—approximately fifty such places are being examined. Some three thousand or more individual tests are being conducted on the rock, the samples of which are being cut into suitable test specimens by a local firm. Testing equipment has been designed and constructed in the Laboratory for the measurement of the mechanical properties of the stone at various sampling positions, such as compressive strength and elasticity, flexural strength and elasticity, shear strength, density, water absorption and associated expansion, and water permeability. The major portion of the testing-work has been completed and some information already supplied for the initial design work.

(10) *Treatment of Timber to obviate Dimensional Change with Humidity.*—A report was made on behalf of a local firm on samples of *Pinus radiata* treated by a patented pyroligneous process intended to give timber stability against change in moisture content with changing atmospheric conditions and resistance to fungal attack. Samples cut to specifications laid down by the Laboratory were supplied,

treated and untreated. These were measured for linear dimensions and moisture content after subjection to each of several known atmospheric conditions (30 per cent. R.H., 50 per cent. R.H., and 85 per cent. R.H.) and the "movement" of corresponding treated and untreated samples compared.

(11) *Recorder for Phosphate-works to register simultaneously Weight and Density of Charges of Acid and Rock: Temperature of Acid.*—The initial general design of the above recorder has been supplied to the works concerned after preliminary experimentation. When approval or suggested modifications have been received by the Laboratory, the detailed design and any necessary developmental work will be continued.

(12) *Equipment for inspecting the Overhead Pantograph of an Electric Locomotive in motion along Rail Track.*—The optical section of the physics laboratory developed equipment described above, from which a design was submitted to the Railways Department. Part of the construction of the prototype is being done by that Department, and the Laboratory will fit and align the optical system.

(13) *Linen Flax.*—Investigations into the quality of New Zealand fibre led to attempts to improve both yield and quality by alterations to the retting process. New methods of determining the optimum retting end-point were found to give improved results, and these were then applied to full-scale trials. Only a slight improvement was obtained, although tests on a small scale continued to show improved yield and quality. Exhaustive tests were carried out to determine the reasons for this, which suggested that variable conditions throughout the retting-tanks made a true end-point determination very difficult. A subsequent attempt to determine a mean end-point by study of the gas-flow from the tanks was inconclusive.

During these tests other experiments were carried out to observe the effect of different retting procedures; samples of green flax were retted direct from the paddock; various methods of drying the flax after retting were tried; improved yields were obtained by careful handling to give improved cutting of the straw, the extent to which scutching was affected by humidifying dry straw was studied fully, and tests were carried out on a turbine scutcher in which a new system of crimping rollers was installed.

A full report on these investigations was supplied to the Linen Flax Committee.

(14) *Meters for testing rapidly the Moisture Content of Wood and of such Materials as Seed, Soil, &c.*—Electric moisture meters have been developed in the electrical laboratory. One is a capacity-operated device, based on a National Physical Laboratory design, and was made to measure the moisture content of wheat.

Another was built for the Army Inspection Department for moisture measurements in *Pinus radiata*. An original circuit was developed which consisted of an electric resistance meter to measure the resistance between two test prods thrust into the timber. The indicating device is a 500 microamp meter and the instrument is calibrated in two ranges having a ratio of approximately 3 to 1 over a total range of approximately 0 per cent. to 30 per cent. moisture.

(15) *Steel-sorter for Rod and Bar Stock.*—At the request of the Public Works Department Mechanical Branch a magnetic steel sorter was constructed, based on a design supplied by them. The device is mains operated, and a magic eye indicates similarity or differences in samples of steel under test. The instrument is sensitive to differences of chemical composition and of physical state, so that it can be used as a hardness comparator also.

It is purely a comparator and a known reference sample is necessary. Other types of electric sorters are being investigated and developed.

(16) *Improved Circuit for D.P.L. Controlling Pyrometer.*—Although no cases of failure had occurred in previous pyrostats, it was considered desirable to have a greater margin of safe operation with voltage variations and other variable conditions.

As a result of considerable investigation a circuit was developed which would operate over a wide range of voltage, was independent of the variations in photo-cell characteristics, and was definitely more reliable under the most adverse conditions.

The new circuit is simpler than previous circuits, and any previous pyrostat can be altered in a few minutes.

(17) *Measurement of Low Rates of Air-movement.*—In connection with the observations on State houses mentioned above, it was found necessary to develop a method of recording estimates of wind velocities down to as low as 3 ft. per minute. A hot-wire anenometer has been designed and calibrated in a wind-tunnel to give repeatable results.

(18) *Standardization of Relative-humidity Measurements.*—Experience has shown that there is great difficulty in obtaining agreement between results from the various standard methods of measuring relative humidity unless great attention is paid to the conditions under which the measurements are carried out. A constant-temperature bath has been designed to hold its temperature to better than $\frac{1}{10}^{\circ}$ C., and in this is inserted apparatus for measuring relative humidity of the dew-point, the wet and dry thermometer, and the chemical (pressure) methods. Accuracy to $\frac{1}{2}$ per cent. is hoped for in all three methods when the experiments in hand have been completed.

*Repairs, Tests, and Calibrations.*—Electrical meters (140), industrial thermometers (45), pyrometers (33), pressure gauges (70), barometers (17), telescopes (32), binoculars (58), rangefinders (7), theodolites (6), sextants (12), chronometers (9), precision clocks (28), stop-watches (14), laboratory balances (9), sets of analytical weights (8), weighing-machines for Transport Department (14), foot candle meters (8), tachometers (6), precision surveyors' levels (6), hydrometers (6), camera lenses (5), butyrometers (23).

Tests were made on the following materials and equipment and statements of examination issued: flame-proofing of aircraft electrical motors; railway-track recorder; fluorescent lamps; tungsten lamps; fibrous cement wallboard and other types of wallboard; corrosion Mazak bomb-tails; chromalloy wire, shipment of; hot-water bottles; canvas water-bags; toothbrushes; fading of paint; asbestos roofing-sheets; pumice concrete; rubber air-hose; catgut; salvus valves for fire hydrants; noise level of aircraft propellers.

### Metrology Laboratory

The manufacture of munitions and other war requirements in New Zealand during 1944-45 has called for large numbers of gauges. Seventeen thousand gauges were certified in all; nine thousand of these were of a uniform simple type. The laboratory now undertakes the checking and sealing of

drawings for the Munitions Department and the Army Inspection Department, and an engineer officer of the laboratory has been stationed in the Munitions Department to assist there with the design of gauges. Several inquiries have been received regarding the possibility of designing and providing gauges for assisting the post-war production of commodities in New Zealand. Gauges have been supplied this year for the inspection of porcelain insulators being manufactured in New Zealand. The laboratory has also taken part in discussions involving a new standard specification for the latter stores. The total number of gauges in existence in New Zealand for munitions production exceeds forty thousand, and the records system to provide details of these gauges, their whereabouts, history, reconditioning, &c., is now a matter of some complexity. The records system laid down in 1942 has functioned smoothly, however, and seems adequate. A report on this system is being prepared. The total value of the gauges in store or in use for which records have been maintained is of the order £250,000.

A considerable amount of work involving control measurements has been done in connection with the clinometer and clinometer-bubble projects.

The metrology staff is participating in the discussions on the planning of acceptance tests for sets of hydraulic gates for the Public Works Department's Karapiro electric-power project.

As usual, numbers of industrial micrometers and standards have been examined and standardized. A set of special gun-bore gauges was certified for the Royal New Zealand Navy.

### Engineering Laboratory

The following subjects have received investigation this year:—

(1) *Measurement of Strain in Steel, due to Welding, on a Bridge Member.*—The heat due to welding may result in a permanent state of stress in the steel neighbouring the weld, which, together with the stress due to the loading to be withstood by the steel, may exceed the maximum permitted by the designer. These measurements were therefore made *in situ* on the actual bridge member in order to compare two different systems of welding the member.

(2) *Development of Resistance-strain Gauges.*—Overseas research has shown that both dynamic and static strain in metals can be determined by bonding an electrical resistance to the metal with a suitable plastic and measuring the change in resistance produced when the metal is strained. The technique of making such resistance-strain gauges has been acquired by trial and error.

(3) *Thermal Conductivity of Refractories: Large-scale Testing Equipment.*—Testing equipment for measuring the thermal conductivity of refractories, samples to be 9 in. by 13½ in. by 2½ in., has been constructed. This equipment is being used to examine New Zealand refractory materials.

(4) *Simple Cut-out Safety Thermostats for Furnaces.*—A need arose, expressed by Air Department, for a simple thermostat which would prevent a furnace from overheating. A suitable instrument cheap to manufacture was designed.

(5) *Hardening of Pivot Steel for Instrument-construction.*—The laboratory has been manufacturing controlling and indicating pyrometers during the year; the correct heat treatment of pivot steel had to be determined for this purpose.

(6) *Measurement of the Temperature of Liquid Steel in an Acid Refractory Furnace.*—Equipment, including a suitable indicating pyrometer, has been developed to make this measurement in order to effect more accurate control over the manufacture of steel castings in New Zealand.

(7) *Casting of Alnico Magnets for Instrument-construction.*—Magnets of suitable size, shape, and characteristics have been cast for incorporation in electrical instruments being constructed at the laboratory for special purposes.

(8) *Hardness Standards.*—Steel pieces of various hardnesses have been made for issue to gauge and tool manufacturers.

(9) *Photo-elasticity Investigations of Sections of the Karapiro Dam.*—Complete equipment for photo-elastic analysis has been built for determining the stresses in models of engineering structures. Comprehensive measurements have been made for the Hydro-electric Branch, Public Works Department, on bakelite model sections of the intake of the Karapiro Dam. The direct object of these measurements was to effect an economy in the use of reinforcing-steel by determining as accurately as possible the positions of the concrete structure where tension had to be counteracted.

Routine testing has covered thermal conductivity (small scale) on fire-bricks; x-ray examination of engine cylinders, propeller naveplate, crankshaft, some thousands of fuzes, locomotive con rod, axles; comparative efficiency tests on piston-rings; hardness tests on wheel studs, ·303 cartridge cases, mortar parts, teat-cups for milking-machines; ductility tests on wire; suitability of burner-plates for stove-construction; fatigue of springs; deflection under load of large water-pipes; thermal expansion of concrete; determination of annealing procedure for welded pelton-wheel buckets for a hydro-electric generator; determination of optimum conditions for extrusion of brass; manufacturing procedure for safety fusible rings; performance tests on refrigerator cooling-fans; examination of spring steel for suitability and heat-treatment procedure; heat-treatment procedures for magnets, brass forgings, mu-metal; procedure for tinning cast iron.

### The Design Section and Instrument Workshops (including Glass-blowing, Glass-grinding, and Electrical Instruments)

The design section has produced detailed drawings for the construction of the following equipment during the year: toolmakers' microscope, engraving-machine, 5,000 lb. universal mechanical testing-machine, equipment for testing strength of canelure fuze 119 caps, thermometer-testing baths, optical lathe, surface-finish recorder, balance for testing thickness of electroplated coatings on steel, indicating pyrometer type A, controlling pyrometer type 103, radiation pyrometer for a rotary cement-kiln, equipment for testing expansion of paper due to moisture or temperature, furnace for the thermal analysis of soils, gauges for porcelain insulators cordeaux thread, inclined tube manometer, 70 lb. pendulum-type tensile-testing machine, diffusion pump for medium high vacua, fractionating diffusion pump for high vacua, pneumothorax medical apparatus, installation D.P.L. controlling pyrometer for lead extrusion press, pivot polishing lathe optical projection with collets for same, shaking table for calibration of vibration meters, complete x-ray crystal analysis apparatus including x-ray tube and pumps, cordeaux form Landis chasers for collapsible tap, micrometer for measuring paper

thickness, air-recirculation furnace, drawing instruments designed for simple production in quantity in New Zealand, vertical illuminator to fit ordinary microscope, differential thermocouple thermometer to measure 15° F. ± 0·1° F., molecular high vacuum fractionating still for removal of vitamin from fish-oil, balanced-coil steel-sorter, stemming-testing machine for fuze filling.

In addition to constructing most of the foregoing equipment, the instruments workshops have dealt with the construction of the following: R.L. optical plotting projectors, toothed section racks and tooth pinions for electric-lamp-making machine, microscope centrescope for jig boring, map converter cartesian to polar co-ordinates, bearing indicators for naval work, navigation computers for aircraft training, interchangeable ground glass joints, microscope mechanical stages, microscope eyepiece micrometer, racks and pinions for weighing-machines being constructed in New Zealand, water-respiration bath for artificial insemination cattle experiments, leica camera adaptors alternative lens, lighthouse lamp transparent covers, spirit-level-grinding machines and testing jigs, water-flow meter, torque tester for hair springs, set-squares and rules for naval range plotting, cloth compressometer, microhypodermic syringe, gas and air supply system for glass-blowing.

An important feature this year of the instruments repair work has been the number of requests concerning medical equipment. Such work, which is generally of a very delicate nature, has not hitherto been attempted on any scale in New Zealand. In no other instance has the efficacy of combined laboratory and workshops facilities been so well demonstrated as in the field of medical instrumentation.

### Tool-room

The tool-room completed the machining this year of some 17,000 gauges, 9,700 precision tools, and 2,400 sight clinometers. The precision tools included ground thread relieved taps and chasers, relieved milling cutters, collets, reamers, broaches, cams, dies, and hobs; a considerable portion of such tools require special heat treatment, for which the Laboratory has a group of modern pyrometrically controlled salt-bath furnaces. This work has been performed strictly to priorities submitted weekly to the Dominion Physical Laboratory by the Munitions Controller.

This section has issued reports on the following: production of ground form relieved milling cutters; production of square-thread ring and concentricity gauges for breech piece 2 in. mortar; production of hardened and ground square-thread gauges for 2 in. mortar; manufacture of chasers for collapsing taps and die heads; design and production of limit gauges for porcelain insulators; design and manufacture of broach for six splined couplings; design and manufacture of machine taps for the 3 in. mortar bomb; production of roller-type screw ring gauges; manufacture of hardened and ground film sprockets; design and manufacture of British standard keyway broaches; the manufacture of gauges and precision tools in the tool-room of the Dominion Physical Laboratory.

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## GEOLOGICAL SURVEY

Director: Dr. J. Henderson

During the year ended 31st March, 1945, the Director made official visits to Karapiro, Rotorua, Waihi, and Thames, as well as to several localities in each of the districts of North Auckland, Huntly, Takaka, and Motueka.

As in the last few years, owing to the manpower situation, geologists carried out geological mapping only as far as was necessary to further their main work—the examination, sampling, and estimating the quantities of mineral deposits of economic interest. The larger areas so mapped were at Maractai (for greywacke), Wanganui (blacksand), Kaitangata (coal), and Mataura-Wyndham (lignite and Fuller's earth). Water-supplies for municipalities, institutions, dairy factories, hostels, and farmers were reported on; some of these will be mentioned later. Reports on engineering prob'ems covered dam-sites, bridge-sites, slumps on railways, and housing areas.

Four officers returned from overseas during the year, one is still in Europe, and two were recently called for service.

### Coal Survey

In six years the Coal Survey has mapped the Grey and Ohai coalfields in elaborate detail. Mr. Gage is preparing the report on the former area, and a beginning has been made on the drawing of the maps and plans, which will show the geology sequence and structure of the coal-measures, bore-sites, mine workings, and the structure contours of an important coal-bearing horizon. Dr. Lillie has completed the manuscript and maps (similar to those of Grey) of the Ohai Coalfield.

Mr. H. W. Wellman has begun the detailed examination of the Reefton Coalfield, and Dr. Lillie of the Kaitangata Coalfield. They find great difficulty in maintaining a field staff sufficient for their work.

Messrs. Gage and Wellman made reconnaissance surveys of areas suitable for opencast coal-mining in the West Coast region. Mr. H. E. Fyfe carried out a similar examination in the Huntly and Waitewhena districts. The former report is now published and the latter has gone forward for publication. Mr. Fyfe also explored the possibilities of the Wanganui basin above Taumarunui as a coalfield. Mr. R. W. Willett examined coal outcrops in two localities near Mount Hamilton in Southland and one at Orepuki. Mr. Fyfe's and one of Mr. Willett's reports are published. Mr. Willett carried on the reconnaissance survey of the lignites in the Mataura-Wyndham area in continuation of his mapping in the Gore district last year.

Mr. Wellman, following a report that thick anthracite outcropped in the upper basin of Fox River, a stream entering the sea halfway between Westport and Greymouth, found a steeply dipping 30 ft. seam in Henniker Creek, exposed by a recent slip. He explored neighbouring streams cutting across the same coal-measures, but in these saw no workable coal of any kind. This and the inaccessibility of the area and its distance from any railway are unfavourable features.

MINERAL SURVEYS

*Phosphates.*—Prospecting of the medium- and low-grade phosphate in the Clarendon district ceased this year; a few patches obviously small or not readily accessible have not been investigated. Mr. Willett's report describing the prospecting and giving estimates of quantities and results of sampling has been forwarded for publication. Mr. E. O. Macpherson's description of the geology of the phosphate accumulations and discussion of their origin was issued recently.

*Serpentine.*—Early in the year the prospecting of the small bodies of serpentine characteristic of North Auckland by magnetometer power-drill and post-hole digger ceased. Mr. J. Healy later made several visits to the Wellsford and Kaukapakapa districts to see how the bodies of rock as quarried agreed with Mr. Fleming's and his own predictions; the estimates were very accurate. Mr. C. A. Fleming on several occasions examined and sampled the serpentine body at Rangikohua, south of Te Kuiti, advised on its survey and prospecting, and estimated the amount of rock occurring. Mr. Willett did the same for the large mass of serpentine quarried at Black Ridge, near Mossburn, Southland. Public Works did the contouring and carried out the pitting and trenching at both deposits. It is hoped to publish the results of all these examinations shortly.

*Limestone.*—There have been many inquiries for limestone from widely scattered localities. Mr. Healy has reported on deposits at Ruatangata, Redvale, Kaipara, and Motatau; Mr. Gage on those near Westport, Inangahua Junction, Greymouth, Ross, and elsewhere on the west coast; and Mr. Willett on those near Clarendon, Balfour, Forest Hill, Isla Bank, and other parts of Southland. Mr. M. Ongley visited deposits at Taylor's Pass and Ward in Marlborough. In addition, information was supplied on the limestones of the Te Kuiti, Taranaki, Gisborne, Wairoa, and Wairarapa Districts.

*Clay.*—Mr. R. F. Hay carried out extensive prospecting and sampling of the surface clays about Putahi, near Kaikohe. These clays are of the decomposed dacitic type that occur at several other points in North Auckland. Most of the known areas in this region have now been prospected by post-hole digging on a grid.

Clay deposits at Ligar Bay and Puramahoi, in the Takaka district, were visited, as was that at Kaka from which the Temuka potteries obtain the supply of fluxing-clay. These clays form beds in Tertiary strata, and at Kaka, reported on by Mr. B. L. Taylor a few years ago, several thousands of tons have been mined. The deposit here is now approaching exhaustion and the pottery company has bored the measures in the hope of locating another lens of feldspathic clay thick enough to mine. So far this work has not succeeded in its object.

Mr. T. J. McKee, of Mapua, showed the writer an extensive area of decomposed granite in the Orinocco Valley some nine miles south-west of the Borough of Motueka. He had washed clay from this granite comparable in quantity and composition with that in the similar decomposed granite about the Baton Saddle, a dozen miles farther south-west. He stated that deposits of the same type occurred in the Sherry Valley, another nine miles to the south. These deposits are all in the same vast mass of granite that extends south from Separation Point to the Buller.

Mr. Macpherson examined and sampled clay deposits east of Levin. The Dominion Laboratory found that this clay would require very careful burning to produce good building-bricks. A report has been published.

Mr. M. Ongley, while on other work, noted that the clay of the Blue Slip and of the slips at Mikonui that have given much trouble to the railways in Marlborough both contained bentonite in substantial amount.

*Silica.*—Mr. Healy forwarded samples from a large deposit of much-jointed white quartzite from the roadside some miles east of Kaeo. This may serve as a source of the silica required in pottery ware.

Mr. Wellman sampled beds of clean loose silica sand in the lower part of the Tertiary rocks near Ross. These were found to be unsuitable as glass-sands, but may have value in some kinds of moulding work.

*Asbestos.*—Messrs. W. E. Hall and J. J. Reid made an examination of the asbestos claim in the upper basin of Takaka River. They mapped the distribution of the gabbro intrusions in the serpentine as well as of the crush zones and shears that traverse the rock.

*Mica.*—The Radio Corporation is working the deposit of mica Mr. Wellman discovered on the west flank of the range south of the Moeraki River. This deposit, which is much lower than the deposit first prospected on the fell fields above, may be worked at all times of the year though the heavy rains prevalent in South Westland cause half the days to be lost in the opencast workings. Good-quality mica is produced in sufficient quantities for the company's requirements. Mr. Wellman is preparing an account, which will shortly be published.

*Feldspar.*—Veins and masses of feldspar occur in the mica-bearing pegmatites of South Westland. As yet little is known of the value of this feldspar.

Mr. Wellman also examined a feldspathic pegmatite exposed in Deep Creek, south of Charleston.

*Iron-ores.*—Mr. Fleming mapped and sampled the dune and beach sands of the Wanganui district. These sands contain many grains of titaniferous magnetite, and the assays for iron, which have not yet been made, will enable an estimate to be made of the amount of iron-ore present in the district.

Dr. C. O. Hutton has now published his estimate of the amount of iron-ore in the dune sands at Fitzroy, near New Plymouth. The content of titania in the concentrated sand is the same as it is in the Patea sands—that is, about 10 per cent. Recent determinations in the Dominion Laboratory indicate that the titania content in concentrates from the large deposits of ironsand at Manukau North Head is about 13 per cent.

There are many thin surface deposits of bog-iron in North Auckland. These contain a certain amount of cobalt, and when ground form a component of salt licks useful in "bush sick" country. Mr. Healy has mapped and sampled a deposit covering some acres on the north side of Lake Omapere.

Other deposits of bog-iron in North Auckland yield paint pigments—ochres and siennas. Mr. Healy has visited and sampled several of these deposits. A similar deposit at Motupipi, near Takaka, contains iron-ore that on fine grinding gives an ochre of pleasing colour and good covering power.

*Copper.*—Mr. Healy, with the Inspector of Mines, visited a recently found copper prospect at Pakotai, north-west from Whangarei. A prospecting programme was outlined.

### Water-supply

As in other years, Mr. Healy has advised dairy factories, drillers, farmers, and others on questions of water-supply and has selected sites for bores.

Mr. Ongley made visits to Blenheim, Wanganui, and Hawera to discuss with engineers the supply of large quantities of subsurface water. His reports on the first two localities have been published.

Messrs. Fleming and Healy completed their examination of the Ngawha hot-spring area. Mr. Modriniak on several occasions, and Mr. Healy once, visited Rotorua and advised on the supply of hot water. The former has published an account of the wells drilled in the borough and discusses the origin of alkaline and acid waters. Mr. Macpherson mapped the springs and gas-vents at the Te Puia hot springs; his report is published.

### Engineering Problems

Mr. Healy advised Public Works about supplies of road metal for a section of the Main North Highway near Maungaturoto and New Zealand Railways on a site for railway ballast near Auckland. Mr. H. J. Harrington carried out a reconnaissance survey of some 250 square miles south of Arapuni Lake in order to locate inliers of greywacke showing through the volcanic rocks from which the coarse aggregate for the proposed dam at Maraetai might be quarried.

Mr. Healy completed his examination of the Maraetai and Karapiro areas, and advised on the site of the proposed water-supply dam at Awakino, in North Auckland. Mr. Wellman re-examined the Cobb Dam site. Mr. Fyfe covered a considerable area of the upper Clarence and Conway basins, where a hydro-power scheme is being considered. Mr. Willett explored an area near Black Jack's Point, in the Waitaki basin, and another area above Roxburgh, on the Molyneux, both possible localities for dams. Reports on most of these examinations will be published.

For New Zealand Railways Mr. Ongley investigated the movement of a tunnel near Oaro, south of Kaikoura, and the slumping ground on the Te Karaka – Otoko section of the Gisborne line.

### Palæontological Work

As in other years, the palæontological work included the examination of current and past fossil collections. Dr. J. Marwick, in addition, revised the New Zealand Cardiidæ and began the revision of the Turritellidæ. Mr. Fleming described New Zealand fossil nautiloids and new species of mollusca from the late Tertiary of the Dannevirke district. He also began an ecological study of the zones of the richly fossiliferous strata of the Castlecliff beds of the Wanganui district.

Dr. H. J. Finlay, the Micropalæontologist, identified foraminifera from many samples sent in by the field officers, chiefly this year from North Auckland, the West Coast, Otago, and Southland. Owing to their wide distribution, microfaunas are of great value in correlating beds in different regions. Dr. Finlay, with Dr. Marwick's help, is working on a revision and extension of the stages of New Zealand's Tertiary strata.

### Petrological Work

Dr. C. O. Hutton made many mineral determinations for the Dominion Laboratory, for Soil Survey, and for other Departments, as well as for commercial firms, &c. He identified rocks for officers of the Survey. He began the systematic examination of the heavy mineral in gravels of south-west Nelson and South Westland. Later he visited the fiords of south-west Otago in order to ascertain if a similar suite of minerals occurred in the beaches of that region.

For the Public Works Department he investigated many samples of rock likely to be used for the coarse aggregate of concrete, and for the Government Architect determined the cause of surface disintegration of a widely used building-stone.

### Geophysical Work

Mr. N. Modriniak carried out magnetic and seismic investigations at Karapiro and Maraetai. At the former locality a number of wells were drilled to determine water-levels. The drill was also used during the early part of the year in prospecting for coal in the Huntly and Glen Massey districts.

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## MAGNETIC OBSERVATORY, CHRISTCHURCH

Director: Mr. H. F. Baird

During the year the customary observational and recording programmes have been maintained. Further progress has been made with the magnetic resurvey of New Zealand, thirty-three stations in the South Island and seventeen in the North Island being occupied.

*Terrestrial Magnetism.*—The three types of photographic variometers by Eschenhagen, Adie, and La Cour gave continuous record of the magnetic elements at our substation in the Amberley Domain. Absolute observations and determination of scale-values there were made weekly as usual. From the hourly measurements of the magnetograms the following mean values for the year 1944 have been derived. These values refer to epoch 1944–45:—

| | Epoch, 1944–45. | Change since 1943. |
|---|---|---|
| Magnetic declination | 18° 55′·0 | +6′·6 |
| Magnetic horizontal force | 22,221·5γ | −0·5γ |
| Magnetic vertical force | −55,200·0γ | +3·3γ |
| Magnetic inclination | −68° 04′·32 | +0′·05 |
| N. | 21,021·4γ | −14·2γ |
| E. | 7,204·1γ | +40·2γ |
| T. | 59,505·0γ | −3·2γ |

Local data of international magnetic character figures have been supplied quarterly to the Secretariat de l'Organization Meteorologique, Lausanne. These figures, together with values of "K," the three-hour range index of geomagnetic activity, have been sent monthly to the Carnegie Institution, Washington, D.C., United States of America. "K"-indices have also been supplied daily to the Defence Development Section.

*Magnetic Resurvey.*—This year field observations have been made at fifty stations throughout New Zealand. Of these, forty-six were new and included two on Stewart Island, while four stations established in the earlier stages of the resurvey have been repeated. It is important to note that included in the number of new stations are seven quite near ones occupied earlier in the resurvey. These earlier pegs were all either ploughed out or their sites under crops, so if the permanency of magnetic survey points is vital to future economic investigations it is desirable that many magnetic survey points be visited every few years. This surveillance can best be accomplished by repeating twenty every year throughout the Dominion and by inspecting all possible in passing. Information throughout the country would then all be modern and the maintenance of a necessary network of stations assured.

In establishing new stations the aim has been to find places with normal magnetic values. For that purpose reconnaissance work has been done with a magnetic balance, usually after discussion with the Director or district officers of the Geological Survey. By this method many normal new stations have been established. It is expected that further similar discussions and reconnaissance work will lead to a better knowledge of areas of normal magnetic value, particularly in Southland. However, some success in this regard has been obtained in Southland, and more particularly in the north-west of the South Island and on the west coast of the North Island between Hawera and Kaipara. Because of the consistent results obtained on the latter two of these extensive stretches, the trend of isogonals there in the final map will be markedly different from those shown on the preliminary map prepared from information obtained up to 1943-45. From other sources preliminary information received for two old stations in the Campbell Islands shows that, although one station was abnormal, the rate of secular variation agreed closely with the trend of isoporic lines extrapolated from the magnetic resurvey results on the mainland. The results obtained from some magnetically anomalous areas definitely points to the need for complementary gravity work.

*Recordings at Christchurch.*—The full programme of earthquake-recording was maintained and the seismological equipment has been kept in critical adjustment. Continuous records were obtained from the cosmic-ray meter, and the results have been forwarded periodically to the Carnegie Institution, Washington. During the year the electrograph building was moved a chain farther east to enable the Returned Services' Association to make a bowling-green in the area adjacent to Victoria Lake. Tabulations of hourly values of potential are well forward. The usual meteorological observations for climatological purposes have been maintained and results forwarded monthly to the Director of Meteorological Services.

## METEOROLOGICAL BRANCH

The Meteorological Branch of the Department which was transferred to Air Department, together with the Apia Observatory, at the outbreak of war, has remained under this control during the year. The report of the Meteorological Branch for the year ending 31st March, 1945, will be found in the annual report of the Air Department.

## IMPERIAL AGRICULTURAL BUREAUX

The Imperial Agricultural Bureaux have continued to provide a valuable link between scientific workers in various fields of agricultural science, particularly within the various countries of the British Commonwealth. The abstracting *Journals* of the various Bureaux and the *Technical Communications* published periodically provide excellent service. It is expected that an Empire Scientific Conference in London in the near future will make recommendations *re* the future of the Bureaux.

In New Zealand co-operation with the Bureaux is maintained through the Department of Scientific and Industrial Research, for which purpose there is a special liaison officer. In addition, contacts with Bureaux and the appropriate fields of research are maintained by official correspondents, who deal with specific inquiries. The Scientific Liaison Officer, London, also has useful contacts with all the Bureaux and is a member of the Council.

## OVERSEAS LIAISON

The Scientific Liaison Officers in London, Washington, and Australia have rendered valuable service during the year in maintaining close contact with the research work in their respective spheres. The volume of technical information coming forward to the Department from these channels has necessitated a special organization at Head Office, Wellington. The information on war projects is showing a slight decline and arrangements are in train for the gradual transition to civil requirements. A very wide range of inquiries have been dealt with by the Liaison Officers and the information received has greatly assisted the Department in keeping abreast with research development in Great Britain, U.S.A., and Australia.

## INFORMATION BUREAU

For some time past it has been evident that there was a real need in the Head Office of the Department for a section (*a*) to act as a clearing house for technical information (local and overseas), (*b*) edit and publish the *Journal of Science and Technology*, bulletins, and other departmental publications, (*c*) arrange suitable publicity of certain of the Department's activities, and (*d*) include the library as an integral unit in the dissemination of information. This was given effect to during the year and an Information Bureau set up in Head Office to co-ordinate the above mentioned functions.

### Technical Information

A wide range of inquiries has been received and dealt with under this heading. A selection of these is as follows: information on organic materials for the production of foam for fire-fighting; soil sterilization; corrosion of metals by tar; preservation of ropes and nets for fishing; treatment of wharf piles to prevent marine growth; production of oil for paint driers; critical temperatures for drying seeds; utilization of wood waste; production of lactic acid; competition of synthetic fibres and wool; D.D.T. and its various uses; insect repellents. Each inquiry is given careful attention, and the various specialists in the branches and divisions of the Department are called upon to assist. It is expected that this service will expand considerably in the near future as a result of close collaboration with the Manufacturers' Research Committee and through plans which are in hand for the wider dissemination of technical information direct to industry. Very close contact is maintained with liaison officers overseas.

### Publications

*Journal of Science and Technology.*—The *Journal* continues to be published monthly. The size has had to be increased to over one hundred pages to meet the great increase in number of papers submitted for publication. The circulation of the *Journal* in New Zealand and overseas is being expanded by all means possible. The more rapid abstracting of papers appearing in the *Journal* is being arranged with overseas abstracting *Journals*.

*Bulletins.*—The following bulletins have recently been published, are in hand, or are about to leave the press:—

No. 89: The Dairy Industry in New Zealand, by W. M. Hamilton. 2s. 6d.
No. 90: Milburn-Clarendon Phosphate Deposits, by E. O. Macpherson. 2s. 6d.
No. 91: Nassella Tussock, by A. J. Healy. 2s. 9d.
No. 92: Soil Erosion in the High Country of the South Island, by J. D. Raeside, H. Gibbs, *et al.* 5s.
No. 93: Prospecting and Mining the Clarendon Phosphate Deposits, by R. W. Willett (in hand).
No. —: Soil Survey of the Hawke's Bay. (Maps in hand.)

*Maps.*—The following maps are being printed:—

Soil map of the North Island (4 ml. to the inch), (in seventeen colours; eight sheets).
Soil-erosion maps to accompany Bulletin 92 (in six colours; three sheets).
Hawke's Bay soil maps (partly printed).
Te Kuiti Subdivision maps (Geological Survey Bulletin), (partly printed).

### Publicity

The preparation and issue of articles for the press, farmers' journals, and popular periodicals dealing with special aspects of the Department's work has been undertaken. This work is regarded of importance in obtaining public support for increases of finance and men for the expansion of scientific research in the post-war period.

### Library

The library is well supplied with periodicals, which are circulated to the appropriate sections of the Department. It is anticipated that the operations of the Manufacturers' Research Committee and the Information Service will throw an additional burden on the library resources. Increased staffing has been necessary to deal with the work, and it is anticipated that a greatly increased reference section will require to be built up to deal with industrial inquiries. Close co-operation is achieved with branch libraries of the Department, other technical libraries, and the Country Library Service.

*Approximate Cost of Paper.*—Preparation, not given; printing (933 copies), £135.

By Authority: E. V. Paul, Government Printer, Wellington.—1945.

*Price 1s. 6d.*]